KELVIN
MAXWELL
FARADAY YOUNG
CAVENDISH
NEWTON

THE INSTITUTE OF PHYSICS

BULLETIN

CONTENTS

Scientific Method . . . . J. Topping 73
and A. J. Woodall 75

Biological Hazards of Ionizing Radiations 77
J. Rotblat

Notes and News 83

The Annual Dinner 85

Correspondence 88

Reviews of Books 89

Forthcoming Institute Meetings 91

The Register 92

Annual Report of the Board 95

The Institute's Journals 111

THE INSTITUTE OF PHYSICS

Officers and Members of the Board, 1958-59

President :

SIR GEORGE THOMSON, M.A., LL.D., Sc.D., Hon.F.Inst.P., F.R.S.

Immediate Past Presidents :

SIR JOHN COCKCROFT, O.M., K.C.B., C.B.E., M.A., D.Sc., F.Inst.P., F.R.S.
O. W. HUMPHREYS, C.B.E., B.Sc., M.I.E.E., F.Inst.P.

Vice-Presidents :

B. P. DUDDING, M.B.E., A.R.C.S., Ph.D., F.Inst.P.
PROF. E. A. OWEN, M.A., Sc.D., F.Inst.P.
PROF. E. C. STONER, B.A., Sc.D., F.Inst.P., F.R.S.
R. W. SILLARS, B.A., D.Phil., M.I.E.E., F.Inst.P.

Honorary Treasurer :

J. TAYLOR, M.B.E., D.Sc., F.R.I.C., F.Inst.P.

Honorary Secretary :

PROF. F. A. VICK, O.B.E., Ph.D., A.M.I.E.E., F.Inst.P.

Ordinary Members of the Board :

M. R. HOPKINS, M.Sc., Ph.D., F.Inst.P.
J.M. A. LENIHAN, M.Sc., Ph.D., A.M.I.E.E., F.Inst.P.
A. C. MENZIES, M.A., D.Sc., F.Inst.P., F.R.S.E.
F. OLDHAM, M.A., B.Sc., F.Inst.P.
J. THEWLIS, D.Sc., F.Inst.P.
J. TOPPING, M.Sc., Ph.D., F.Inst.P.
L. R. G. TRELOAR, D.Sc., Ph.D., F.Inst.P.
G. W. WARREN, M.B.E., B.Sc., F.Inst.P.

Chairmen of Branches in Great Britain :

Liverpool and North Wales : F. I. HURLEY, B.A., B.Sc., F.Inst.P.
London and Home Counties : PROF. A. M. TAYLOR, M.A., Ph.D., F.Inst.P.
Manchester and District : PROF. H. LIPSON, M.A., D.Sc., F.Inst.P., F.R.S.
Midland : R. E. BASTICK, B.Sc., Ph.D., A.Inst.P.
North-Eastern : O. P. T. KANTOROWICZ, Ph.D., F.Inst.P.
Scottish : R. M. SILLITTO, B.Sc., F.Inst.P.
South Wales : M. R. HOPKINS, M.Sc., Ph.D., F.Inst.P.
South-Western : PROF. S. H. PIPER, D.S.O., D.Sc., F.Inst.P.
Yorkshire : A. B. D. CASSIE, C.B.E., M.A., D.Sc., F.Inst.P.

Nominated by The Physical Society :

H. H. HOPKINS, D.Sc., F.Inst.P.
D. A. WRIGHT, D.Sc., F.Inst.P.

Secretary :

H. R. LANG, B.Sc., Ph.D., A.R.C.S., F.Inst.P.

Deputy Secretary :

N. CLARKE, B.Sc., F.Inst.P.

47 BELGRAVE SQUARE, LONDON, S.W.1. TELEPHONE : BELGRAVIA 6111-2-3

Appointments Vacant

The inclusion of particulars of a vacancy must not be taken to imply that the Institute necessarily approves of the terms offered or that might be offered. Candidates should satisfy themselves that these are satisfactory, and they may always refer to the Institute for advice.

ROYAL AIRCRAFT ESTABLISHMENT

RESEARCH FELLOWSHIPS

Ministry of Supply invites application for a limited number of SENIOR AND JUNIOR RESEARCH FELLOWSHIPS tenable for two or three years at the Royal Aircraft Establishment, Farnborough, Hants., commencing Autumn, 1959.

Fellows will be required to carry out fundamental research in connection with advanced rocket and aircraft projects. The scientific fields covered include aerodynamics, thermodynamics, aircraft and missile structures, guidance and control techniques, etc. Subjects will be selected according to the training and experience of the Fellows and the interests of the Establishment.

Candidates must be British with normally a first or second class honours degree in the natural sciences, mathematics or engineering, with evidence of a very high standard of ability in research. Exceptionally a candidate without the academic requirements, but who can produce evidence of outstanding ability in research, may be admitted. At least two years' postgraduate research experience required for Junior Research Fellowship (age preferably 23-26) and three years for Senior Research Fellowship (age preferably 26-30).

Remuneration according to individual merit on ranges £1100 – £1350 (Senior Research Fellowship) £750 – £1000 (Junior Research Fellowship) a year. Superannuation under F.S.S.U. At the expiry of Fellowship the holder, if of suitable age, can be considered for an established post at the Establishment.

Application forms from the Director, Royal Aircraft Establishment, Farnborough, to whom completed forms, together with suitable testimonials regarding research ability and where possible, copies of candidates' published papers, must be returned by April 17, 1959. Overseas candidates should submit written applications stating age, nationality and place of birth of self and parents, academic qualifications, appointments held and research experience.

THE ROYAL COLLEGE OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF TEXTILE TECHNOLOGY

Applications are invited from graduates with honours degrees in physics for LECTURESHIP in textile physics. Industrial experience an advantage. Duties will include research and advanced lectures to honours degree and associateship students.

Salary within scale £900 to £1,650 F.S.S.U. superannuation and family allowances.

Application forms and further particulars from the Secretary, George Street, Glasgow, C.1.

UNIVERSITY COLLEGE OF NORTH STAFFORDSHIRE

Applications are invited for the post of ASSISTANT LECTURER in physics. Salary in the scale £700 × £50 – £850 p.a. with F.S.S.U. and children's allowances. Applications should reach the Registrar, The College, Keele, Staffs. from whom further particulars and application forms may be obtained, not later than April 20, 1959.

MINISTRY OF SUPPLY, NATIONAL GAS TURBINE ESTABLISHMENT, Pyestock, Hants, requires AERODYNAMICISTS, MECHANICAL ENGINEERS, PHYSICISTS AND MATHEMATICIANS for gas turbine research in relation to propulsive systems for flight. (*a*) SENIOR SCIENTIFIC OFFICER (minimum age 26 and at least three years postgraduate research experience) or (*b*) SCIENTIFIC OFFICER. 1st or 2nd class honours degree or equivalent required for both grades. Salary ranges (*a*) £1,166–£1,380 (*b*) £615 – £1,090 (male). Superannuation under F.S.S.U. Opportunity if under 31 to compete for established (pensionable) posts. Knowledge of recent developments in gas turbine field desirable but candidates to whom the subject is new can broaden their experience before taking up specific duties. Houses available for letting to married staff. Forms from M.L.N.S. Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C207/9A.

BRADFORD INSTITUTE OF TECHNOLOGY

Principal:

E. G. Edwards, Ph.D., B.Sc., F.R.I.C.

Applications are invited for the post of SENIOR LECTURER in physics in the Institute. The Senior Lectureship is one of a number of additional posts established as a result of the extension of the work of the department.

Candidates for the post should be well qualified physicists, and some experience of the application of physics in industry would be a recommendation. The capacity to guide research work is a desirable qualification and suitably qualified candidates will be given the time and facilities to undertake research.

The salary scale for men, in accordance with the Burnham Technical Award, is from £1417 10s. 0d. to £1627 10s. 0d. per annum.

Previous industrial or research experience at a suitable level may be taken into account in fixing the commencing salary. Further particulars of the appointment and forms of application may be obtained from the Registrar, Bradford Institute of Technology, Bradford, 7.

W. H. Leathem,
Clerk to the Governors.

ROYAL RADAR ESTABLISHMENT RESEARCH FELLOWSHIPS

Ministry of Supply invites applications for SENIOR AND JUNIOR RESEARCH FELLOWSHIPS tenable for three years at the Royal Radar Establishment, Malvern, commencing Autumn 1959.

Considerable choice of subjects within the fields of interest to the Establishment. These include experimental and theoretical research in low temperature physics ; electrical and optical properties of semi-conductors ; infra-red spectroscopy ; microwave physics including resonance techniques ; electronics and radio astronomy.

Candidates must be British with normally a first or second class honours degree in an appropriate subject, with evidence of a very high standard of ability in research. Exceptionally a candidate without the requisite academic qualification, but who can produce evidence of outstanding ability in research, may be admitted. At least two years' postgraduate research experience required for Junior Research Fellowship (age preferably 23-26) and three years for Senior Research Fellowship (age preferably 26-30).

Remuneration according to individual merit on ranges £1100 – £1350 (Senior Research Fellowship), £750 – £1000 (Junior Research Fellowship) a year. Superannuation under F.S.S.U. At expiry of Fellowship the holder, if of suitable age, can be considered for an established post.

Application forms from the Director, Royal Radar Establishment, Malvern, Worcestershire, to whom they must be returned by April 24, 1959.

Ministry of Supply, Royal Radar Establishment, Malvern, offers first-class opportunities to SCIENTISTS in very wide range of research and development work including solid state physics, radio astronomy, advanced computing techniques, electronics and radar. Well equipped laboratories near attractive residential area at foot of Malvern Hills. Official hostel and housing scheme. 5-day week. Appointments in grade (*a*) SENIOR SCIENTIFIC OFFICER (minimum age 26 and at least three years postgraduate research experience) or (*b*) SCIENTIFIC OFFICER. 1st or 2nd class honours degree or equivalent required for both grades. Salary ranges (*a*) £1,166 – £1,380, (*b*) £615 – £1,090 (male in provinces ; rates for women same by 1961). F.S.S.U. Superannuation. Opportunities if under 31 to compete for pensionable posts. Forms and illustrated booklet from M.L.N.S. Technical and Scientific Register (K), 26 King Street, London, S.W.1 (quote A132/9A).

ENGLISH ELECTRIC
(ATOMIC POWER DIVISION)
REACTOR ENGINEERING DEPARTMENT, Whetstone, Near Leicester
PERFORMANCE AND CONTROL OF NUCLEAR POWER STATIONS

Several vacancies both junior and senior arise in the department engaged in this work. In particular we need :

ENGINEERS OR PHYSICISTS to undertake performance calculations with special reference to reactor optimization, economics and cost forecasting. Also to investigate improvements in the computational techniques of nuclear power station optimization.

PHYSICISTS OR MATHEMATICIANS to take part in theoretical work on various aspects of nuclear design and reactor physics. The work will involve the solution of many novel and interesting problems.

ENGINEERS for work on reactor and power station control problems. This will include the formulation and functional specification of control systems for reactors and complete power stations. Much of this control will be automatic, and investigation of loop stability, transient responses, operational sequences, and plant safety under fault conditions will be required.

Digital and analogue computing facilities are available for aiding the solution of nuclear, performance and control problems.

Senior candidates will probably be 27-32 years of age, with a good degree. They will generally be placed in charge of a small group devoted to some vital aspect of design. In the case of control engineers, familiarity with basic control theory and some appreciation of heat flow problems would be especially valuable.

Junior candidates should have sound basic academic qualifications in their subject, though in the case of engineers, a degree is not essential, if suitable industrial experience exists.

Previous experience in this field, though a considerable asset, particularly for senior applicants, is not essential, as training can be given. Initiative, ability to become " self-propelled," and a keen desire to learn about the whole project are characteristics which will be considered as important as technical qualifications.

If you feel you are suitably qualified, and would like to become a member of the team that designed and are now building the world's largest Nuclear Power Station at Hinkley Point, then write giving details of qualifications and experience to Dept. C.P.S., Marconi House, 336/7 Strand, W.C.2, quoting reference PB.1895D.

NATIONAL COLLEGE OF FOOD TECHNOLOGY

CRANWOOD STREET, CITY ROAD, LONDON, E.C.1

Principal:
J. D. Mounfield, M.Sc.Tech., Ph.D., F.R.I.C.

Applications are invited for the post of ASSISTANT LECTURER in the college from Graduates in physics or engineering. Special consideration will be given to applicants with experience in industrial engineering.

A new college, now almost completed at Weybridge, Surrey, will come into use in October this year and the candidate appointed will be expected to assist with the development of the courses there. New laboratories will provide facilities for original work.

Salary scale : £813 15s. 0d. × £26 5s. 0d. – £1207 10s. 0d. The starting salary will be dependent on qualifications and experience.

Application forms (obtainable from the college) should be sent to the Principal as soon as possible.

PHYSICIST to design and re-design laboratory apparatus for use in the teaching of physics at all levels. Interesting post of wide scope in North London. The teaching experience of a technical college lecturer who has a well developed engineering bent might ideally fit him for this post. 5-day week. Pensionable. Apply Research Director, Griffin & George (R & D) Limited, Ealing Road, Alperton, Wembley, Middlesex.

COMMONWEALTH OF AUSTRALIA

AUSTRALIAN ATOMIC ENERGY COMMISSION

Applications are invited for the undermentioned position. Salary shown includes the present cost of living adjustment of £63(A) per annum. Commencing salary will be determined in accordance with the applicant's qualifications and experience.

Technical Physics Section. RESEARCH OFFICER (PHYSICIST) £1326-1951 (A). Position R.73.

Duties : Conduct research into radiation detection techniques and also to develop specialized nuclear particle detectors.

Qualifications : University degree with first or second class honours in physics or equivalent qualifications with post-graduate experience in radiation counter techniques. To be thoroughly conversant with the physics and construction of ionization chambers, proportional counters, scintillation counters, etc. Knowledge of high vacuum and modern laboratory techniques desirable.

Applicants should include full name, date and place of birth, nationality, marital status, present position and salary, qualifications, experience, particulars of any publications and the names and addresses of at least two referees who may be contacted *re* technical experience, when prepared to commence and quoting the position number should be forwarded to : A.A.E.C. Liaison Officer, Australia House, Strand, London, W.C.2. Not later than Friday, April 24, 1959.

THE UNIVERSITY OF SHEFFIELD

DEPARTMENT OF GLASS TECHNOLOGY

Professor:
R. W. Douglas, D.Sc., F.Inst.P., F.S.G.T.

Applications are invited from candidates with qualifications in either chemistry or physics or glass technology for a post of LECTURER in the department, to begin duties as soon as possible. Previous experience in the Glass Industry, though desirable, is not essential. Initial salary according to qualifications and experience on the scale £900 × £50 – £1,350 × £75 – £1,650, with F.S.S.U. provision and family allowance. A grant towards removal expenses will be made. Further particulars should be obtained from the Registrar to whom applications (4 copies) should be sent by April 25, 1959.

THE UNIVERSITY OF SHEFFIELD

RESEARCH FELLOWSHIPS IN THE DEPARTMENT OF GLASS TECHNOLOGY

Applications are invited for a Senior Research Fellowship and two Junior Fellowships or Scholarships, which will become vacant during the next three months. Candidates should be graduates in either chemistry or physics or glass technology. The value of the senior Fellowship will be between £750 and £1,000 per annum, with F.S.S.U. provision, that of the junior Fellowships and Scholarships between £350 and £500 per annum. Further particulars should be obtained from the Registrar to whom applications (three copies) should be sent by April 25, 1959.

THE INSTITUTE OF PHYSICS

Vol. 10 No. 4 BULLETIN **APRIL 1959**

Published by The Institute of Physics for circulation to its members

Scientific Method

On January 21, 1959, the Education Group held a discussion on " scientific method " at the Institute's House. The two opening contributions by Dr. J. Topping and Professor A. J. Woodall are reproduced below.

(i) By J. TOPPING, M.Sc., Ph.D., F.Inst.P.

(Principal, Brunel College of Technology, Acton, Middlesex)

I ASSUME that we approach this discussion mainly as teachers; that is, we are concerned with the problems involved in teaching scientific method or in helping students through our teaching to appreciate what scientific method is. We are not, I take it, primarily concerned with some of the philosophical aspects of the subject.

I assume too that we mean by scientific method that combination of observational procedures and theoretical analysis that is exemplified outstandingly in the work of Newton. It is sometimes summarized in the sequence which includes observation, hypothesis-making, further experiments to test the hypothesis and finally the establishment of theories or laws. The theories are subject to constant check or change in that they must lead to results which are in agreement with new measurements.

We shall agree that most physicists get some idea of what scientific method is through their study of the work of great physicists; one cannot understand the work of Newton, Young, Ampère, Faraday, Maxwell, J. J. Thomson and Rutherford without getting some glimmer, at least, of what is common to their activity. A feature of scientific education in the past has been that students have learned of scientific method in this way, that is, indirectly or by implication; they have been " exposed " to it. It is sometimes suggested that they have learned little or nothing and I am tempted to take such an extreme view!

What I wish to plead is that our teaching of scientific method should be more specific and direct and that we should take every opportunity in our lectures of emphasizing its incidence in the work under discussion. It may be that we should not thereby produce better physicists, although I suspect we would. An understanding of what physicists are really doing when they are working as physicists, an appreciation of the sort of questions they ask and the sort of answers they can give, some understanding of the problems which may not be susceptible to the application of their particular method—these are matters which any consideration of scientific method would illuminate and seem to me worthy of inclusion in any educational scheme for physicists. We should not underestimate the possibility that the liberal element in scientific education might mainly reside here.

In case the term *scientific method* might suggest that all scientific research is carefully planned in every detail, I must say at this point that I am very much aware that scientific work and particularly creative scientific work cannot be contained within the restrictive strait-jacket of some carefully defined procedure, and that it would be foolish to suggest that anything which did not strictly conform to this definition was not scientific.

The initiation of research particularly depends on all manner of factors, not least on physical insight or on chance or on having " a bright idea." There are many well-documented examples; if not Newton, there are Kekulé and Bragg. This aspect of scientific activity is not very different from any other creative activity in fields outside science; what is different is the procedure followed subsequently in testing or developing the idea.

Often people talk of doing something " scientifically " when they usually mean analysing a problem in a common-sense fashion. This analysis is of course important, and is often a necessary preliminary to any application of scientific method. We all know how important it is to ask the right questions, and the questions (right or wrong) dictate the experiments.

Again, procedures in scientific work may not be models of methodical planning; as written up they might appear so, but seldom do these accounts give the sequence in which the work has been carried out. Scientific papers rarely reveal the mistakes made or the blind alleys that the worker groped along before he returned to take another road. Nevertheless, there are certain characteristics of these procedures which, as I said earlier, are referred to as scientific method.

At the end of last century, Karl Pearson in his *Grammar of Science* could speak confidently of scientific method and say " The classification of facts and the formation of absolute judgements upon the basic of this classification —judgements independent of the idiosyncracies of the individual mind—essentially sum up the *aim and method of modern science.*" And he repeats " The man who classifies facts of any kind whatever, who sees their mutual relation and describes their sequences, is applying the scientific method and is a man of science."

To-day perhaps, we speak with less cocksureness and recognize a plurality of scientific methods rather than one scientific method. A contemporary point of view is well expressed by Hall in his excellent work *The Scientific Revolution.* He writes, " It cannot be claimed that any scientific method is correct, without considering the nature of the objects it seeks to achieve. Both may be subjected to criticism, for it may be asked whether scientists have the proper aims, or whether they are using fit methods; and, indeed, from the thirteenth to the seventeenth centuries there was continuous and effective criticism of science from each of these points of view. During the eighteenth and nineteenth centuries, however, there was a tendency for practising scientists to feel a confident complacency concerning their aims and methods, and to envelop themselves in an impenetrable detachment from any attempt to interpret their activities philosophically. They were scientists, devoted to a peculiarly rigorous pursuit of knowledge, not natural philosophers. They despised metaphysics and logic. Their limited outlook, and their often shallow pragmatism, would have been intolerable to the Greek founders of scientific method."

I suppose that after Newton's amazing successes it was not surprising that physicists, and scientists generally, were content. The method worked. We, however, have lived through a revolution in physics possibly more fundamental than that of the seventeenth century.

It is perhaps in reaction to the strange consequences of relativity, quantum theory and wave-mechanics that many to-day lay special stress on the experimental or observational element in science. But science is more than " doing experiments " or collecting observations. It is true that we are sometimes forced just to " see what happens," but more often experiments are designed to answer specific questions. Chadwick's experiments which established the existence of the neutron are a good example of the latter.

Men have been observing and doing experiments for a long time. Aristotle made use of experience and observation, but he derived his universal truths first. It was not science as we know it now.

Again, Bacon may give the impression in his writings that collection of observations is all-important, but he was aware of the need for doing experiments and indeed of the importance of designing a " crucial " experiment to decide between alternatives. What one misses of course is any reference to the quantitative, to measurements. A. N. Whitehead has commented: " Search for measurable elements among your phenomena and then search for relations between these measures of physical quantities. Bacon ignores this rule of science. Perhaps he was misled by the current logical doctrines which had come down from Aristotle. For, in effect, these doctrines said to the physicist ' classify ' when they should have said ' measure '."

Science may be more indebted to ancient Greece and to the Middle Ages than we sometimes admit, but there cannot be any doubt that the seventeenth century, particularly through the work of Galileo and Newton, saw developments in physics which constituted a revolution in science. It is the method implicit in their work that most of us think of as scientific method.

Criticism of education in physics must refer to both scientific method and what I have called analysis.

As to scientific method there is a need for explicit teaching. This must inevitably involve some account of the historical development of science and of some of the philosophical implications. It may be that because of limits of time we might have to restrict ourselves to the seventeenth century, but if so the work of Newton is excellent material. There should also be some discussion of such topics as the nature of " explanation," the sort of answers that are acceptable in science and the use of concepts and models. Hall points out " The history of the scientific revolution shows the fertility of the critical examination of concepts and theories, even when the modification of the simple account of the facts is insignificant (as with Galileo's new concepts of inertia and acceleration)."

As to analysis we need to consider how a scientist faces a new situation, how a problem is broken down into simpler problems, how decisions about equipment and the appropriate accuracy are made. How are we to do this ?

I wish to mention rather briefly three ways in which this can be attempted; Professor Woodall is to give some examples in more detail. Firstly, through the ordinary lecture courses; ideally this is the best way, as part of our normal teaching. Scientific method is not a special aspect of physics, it is physics. Inclusion of these topics would, I think, transform our teaching. What is significant and unfortunate is that few teachers feel able or willing to do it. Not having learned, they cannot teach. It is a sad commentary on university education in the past; happily there are signs that in the future it might be different. Interesting experiments are being tried in Cambridge, and the recent policy statement of the Science Masters' Association, *Science and Education*, suggests that the schools are making useful changes in their teaching.

Secondly, there is a need for special courses dealing with scientific method and some aspects of the history of science; at Brunel, in the Diploma in Technology courses, we have organized courses in what is called " fundamentals of science." Special courses of this or of similar kind will be necessary as long as we do not achieve through the ordinary lecture courses what we have in mind. But, however successful we may be, these special courses are justified on other grounds. Among these I should include, (*a*) the need for a course to review some of the basic physical concepts at a time when students have wider knowledge and greater maturity; the final year may be the best time; (*b*) the need to introduce physicists to some of the special problems in other sciences, e.g. biology and the use of statistical methods, (*c*) the need to appreciate some limitations of scientific method, (*d*) an opportunity to discuss the social relations of science and some of the social problems of this technological age.

The third way is through reform of our practical courses. In such a rapidly expanding subject as physics, the pattern of laboratory work is always in need of overhaul. But in addition we should do well so to modify some of the exercises that the students are presented with " real " situations simulating in some measure those of an industrial or a research laboratory. Students would need to work out their own methods and decide the equipment required. The project, in the Diploma in Technology courses, is so designed.

I hope I have said enough to introduce this subject. It is reassuring to know that teaching experiments are being tried in schools and technical colleges and universities.

(ii) By Professor A. J. WOODALL, O.B.E., B.Sc., Ph.D., F.Inst.P.

(Associate Professor of Physics, Royal Military College of Science, Shrivenham)

TEACHING METHOD: TYPES OF AUDIENCE

DR. TOPPING has discussed the nature of our subject, " Scientific Method." We would indeed be naive if we expected to convert an indifferent scientist into a good one merely by instilling into him the principles of scientific method but we scientists are in the good company of painters, architects, medical men, generals, musical composers and many excellent craftsmen if we include in the training for our profession some study of the rules of the game. Scientific investigations of different kinds fall into recognizable patterns much as musical compositions do. There are many pitfalls in science and some of these may be recognized and avoided.

For the purposes of this discussion, it is convenient to recognize three main requirements for formal instruction in scientific method:

(i) for the professional in training, whether destined for fundamental pure research or for technology, to widen horizons, provide perspective and to improve technique;

(ii) for the teacher of science, so that he may learn to permeate all his science teaching with the right spirit;

(iii) for the non-scientist who is likely to come into professional relations with scientists or to have important concern with science and technology, to confer a deeper understanding of the power and the limitations of science and a sympathy with scientists in their work and also perchance to stimulate where appropriate extensions of scientific methods in wider fields of human endeavour.

Category (i) should receive a fair indoctrination in the principles of scientific method as part of normal training. However, experience in conducting practical examinations suggests that much of the physics teaching of this country, at school and university, conveys very little of this spirit of science. A student who squares a periodic time before plotting against a length should have some idea why this combination of variables is selected and at least a few times in his career, he should be left to choose the combination himself. Again, barriers between academic tuition and real life should be dissolved; if a pupil cannot apply in other affairs the methods of measuring, analysing data and checking hypotheses which are used in science, a large part of the educational effort is wasted.

For students in this category, the discussion of scientific method should not stop at the Galileo-Newton stage nor should attention be confined to the deduction of physical laws. A breath of fresh air comes into the subject with the inclusion of biological examples and the educational value is enhanced. This contribution can hardly be squeezed into physics periods and it is best therefore to have some specific discussion of scientific method.

Now let us consider examples of methods found effective with various types of audience but especially suitable for the third category.

METHODS OF INTRODUCING SCIENTIFIC METHOD

In designing a course, there is a danger in making every step very clear and obvious because the audience may feel that scientific method is simply an elaborate procedure to reach conclusions which could have been foreseen on common-sense grounds. It is therefore advisable to include some examples where the " obvious" solution turns out to be in error. Moreover drama which is inherent in some investigations should be highlighted to capture the imagination. This likewise helps dispel the erroneous impression that to use scientific method implies being dully methodical.

(*a*) A shortened version of Newton's investigation of the spectrum forms a good introduction for many audiences because it is colourful and fairly simple to follow. When sunlight is in poor supply, a tolerable imitation can be achieved with a motor-car headlamp as source, behind a collimating lens in a tube. The spectrum then gives overlapping images and an impure spectrum as in Newton's original work. One follows first the failure of the hypothesis that the prism makes the colour and then introduces the new hypothesis that the prism is sorting constituents already present. One can round this work off by using Newton's colour-top.

(*b*) If the sun is shining directly into the class-room, place a small round mirror where a spot will be thrown on the ceiling. This is observed to be round, like the mirror. A large rectangular mirror gives a large rectangular patch; the audience will readily agree that the patch has the shape of the mirror. Cover part of the rectangular mirror to make it a triangle, and the hypothesis is verified. Just to make sure, proceed to a small triangle—whereupon the patch appears circular once more. The ensuing discussion is usually very informative. The beauty of this experiment lies in the simplicity of the apparatus and the link with every-day observation. Students of physics should see the connection with the pin-hole camera.

(*c*) The weakness of tests with inadequate numbers can be brought out by using packs of cards or sets of draughtsmen or other objects in two colours. To test whether the products of firm A (represented by the contents of one pack or box) are superior to those of B, it is agreed to take samples in turn from each, recording

" good " or " bad " according to colour. After each draw, the products are restored to their fellows and reshuffled so that conditions remain the same throughout the test.

The actual drawing and recording can be done by the class. The instructor interrupts the process at various stages, e.g. " if you had only tested a pair of samples for each, you would have concluded that B was superior." With say, 18 " good " in box A to 12 " bad," and the reverse ratio in B, it is necessary to test for some time before the superiority of A becomes unassailable.

This exercise is a useful introduction to the necessity for statistical methods in some types of investigation.

(*d*) The audience should be shown that reported " facts " and hearsay are not acceptable as bases for scientific work until verified. In this phase of the work, deal with such popular beliefs as the one that sunlight puts fires out, that hand-basins empty counter-clockwise in the Northern hemisphere and so on. Where possible, the class should carry out investigations into such matters on their own.

There are many classic examples of scientists insisting on experimental tests despite adverse climate of opinion. One of these is Arago's successful search for the bright spot in the shadow of a circular object. This turned Poisson's objection to Fresnel's wave-theory into a triumphant success. (Marconi's success with long-range wireless transmission in the face of current denial of the possibility is another.) The experiment can be made dramatically successful with a small class but it is unwise to attempt it with a gathering of elderly non-scientists whose failing vision can rarely cope with the unfamiliar viewing of diffraction phenomena through an eyepiece.

(*e*) Nearly all the phenomena so far discussed are physical and are under control. Next one should be shown how to cope with random variations and eventually with experiments in which the subject-matter reacts as with tests on human beings and other animals. The division of land into plots for alternative agricultural treatments and the use of " controls " should be explained. Then when it seems that with controls nothing can go wrong, the famous Hawthorne experiments(1) should be quoted, in which astonishing results were obtained by studying one group of operatives against the rest of the shop taken as a control. This investigation has some very salutary lessons for those who lose their sense of perspective in trying to be scientific in all things.

Another valuable example for discussion is that of Clever Hans, the calculating horse(2).

The life of Pasteur provides several shining examples of accepted scientific method, backed by a sense of drama which appeals to many audiences.

(*f*) The class should be encouraged to devise and carry out one or more experiments. Mr. C. B. Daish and I were fortunate in being able to probe with an adult class the ministerial statement of some years ago that butter and margarine could not be distinguished apart. Again, one can devise tests to decide between contradictory advice proffered by " experts " in horticulture or other subjects, opportunity being taken to point out the many traps when one attempts this type of experiment on too small a scale.

(*g*) Finally, the gross errors daily committed by the most august bodies which sit in judgement on their fellows, whether as examiners, appointing committees or governing bodies, can be reviewed. Excellent study material is available (Hartog and Rhodes: *An Examination of Examinations;* and, without being unduly flippant, Parkinson: *Parkinson's Law*). The appointing committee, it seems, errs in using too small a sample, for its probing questions are too few to be reliable in uncovering weak places and bringing out strength and its reactions to such random discoveries as it makes are too violent. Examinations in many disciplines are almost useless for assessing merit and there must be many tragedies wrought by a misplaced faith in " the wisdom of experienced examiners." Those in senior positions would be humbler and better for studying these aspects of their decisions.

To conclude, it is vital to remember that scientists are human and that scientific method does not comprise an infallible set of rules which will enable mediocre persons to obtain first-class results. However, a knowledge of the fabric of the subject acts as a worth-while background to scientific work much as our use of language can be helped by a knowledge of grammar and derivation. We can achieve more and we can have more enjoyment in the attainment if we understand what we are about.

REFERENCES

1. L. Urwick and E. F. L. Brech, *The Making of scientific management*, Vol. 3 *The Hawthorne Investigations*, Management Journals, 1948.
2. H. Munro Fox, *The personality of animals*, Chap. X, Pelican book, A78, 1940.

READING LIST

Beveridge, W. I. B., *The art of scientific investigation*, Heinemann, 1950.

Braithwaite, R. B., *Scientific explanation: a study of the function of theory, probability and law in science*, Cambridge University Press, 1953.

Brown, G. B., *Science: its method and philosophy*, Allen & Unwin, 1950.

Butterfield, H., *The origins of modern science*, Bell, 1949.

Cohen, M. R. and Nagel, E., *An introduction to logic and scientific method*, Routledge & Kegan Paul, 1934.

Crombie, A. C., *From Augustine to Galileo*, Falcon Press, 1952.

Hall, A. R., *The scientific revolution* 1500-1800, Longmans, 1954.

Hartog, Sir P. and Rhodes, E. C., *An examination of examinations*, Macmillan, 1935.

Holmstrom, J. E., *Records and research in engineering and industrial science*, Chapman & Hall, 1956. (Contains a useful bibliography.)

Northop, F. S. C., *The logic of the sciences and the humanities*, Macmillan, 1947.

Parkinson, C. N., *Parkinson's Law*, Murray, 1958.

Pearson, K., *The grammar of science*, orig. 1892; Dent, 1937.

Pledge, H. T., *Science since 1500*, H.M.S.O., 1939.

Popper, K. R., *The logic of scientific discovery*, Hutchinson, 1959. (Translation from the German: *Logik der Forschung*, Springer, 1934.)

Ritchie, A. D., *Scientific method*, Kegan Paul, 1923.

Waddington, C. H., *The scientific attitude*, 2nd ed., Penguin Books, 1948.

Wilson, E. B., *An introduction to scientific method*, Routledge & Kegan Paul, 1934.

Whitehead, A. N., *Science and the modern world*, Penguin Books, 1938.

Biological Hazards of Ionizing Radiations*

By Professor J. ROTBLAT, M.A., D.Sc., F.Inst.P.

(*Medical College of St. Bartholomew's Hospital, London*)

Within a few months after their discovery X-rays were used in medicine as an aid to diagnosis; shortly afterwards they began to be used also for the treatment of cancer. It took only a little longer to discover their adverse effects; many of the earlier workers with X-rays suffered pain and disease and some died from the effects of radiation. Nowadays ionizing radiations loom enormous in people's minds. The atomic age has brought with it a multitude of beneficial uses of radiations but it has also demonstrated that misuse may result in suffering and unhappiness for generations to come.

Although the physical nature of the radiations is well understood, we know very little about their interaction with the living body. In general radiations destroy; even their curing action is based on the killing of diseased cells, but nobody knows exactly how this destruction occurs. We know that if a system is exposed to radiation, the energy absorbed is ultimately converted into heat, causing a rise in temperature. But the increase in temperature resulting from a lethal dose is only one thousandth degree centigrade. The body can receive a thousand times more energy without any serious damage. This shows that the destructive action of the radiation occurs in a unique and insidious manner. Indeed, one may receive a lethal dose of radiation without being aware of it for some time. It has been stated recently that animals appear to have a sense for detecting radiation; mice put in a cage of which only part is in the field of the radiation, apparently move away from the irradiated area. This result still requires confirmation, but so far nobody has claimed that any such sense exists in man.

Although the mechanism of the action of radiations is still unknown, a large wealth of information has been accumulated about the various effects which they produce in the living organism. These effects can be grouped under three headings: acute effects, which are noticed within a few days or a few weeks after exposure; long term effects, which may not become apparent for many years after exposure; and genetic effects which may not manifest themselves for many generations.

ACUTE EFFECTS

If the whole body is exposed to a single large dose of radiation, various symptoms, described as radiation sickness, appear within a few days. These may include changes in the blood, skin burns, loss of hair, temporary sterility and, if the dose is big enough, nausea, vomiting, high temperature and death, usually within two or three weeks. A given dose of radiation will not always kill; there is a chance of survival, but the larger the dose the smaller this chance. Figure 1 illustrates the variation of this probability with the dose measured in rads. (The rad is the unit of absorbed dose and is equal to the absorption of 100 ergs per gram; it is practically the same as the röntgen.) This so called sigmoid curve was derived indirectly from animal experiments, because, apart from Hiroshima and Nagasaki, there have been, fortunately, only a few instances of people receiving large doses of radiation accidentally. It will be noticed that with a dose of 300 rad the chances are 50/50, this means that of a large population exposed to such dose, half would die within a few weeks. This dose is called the LD_{50}. But half this dose would hardly kill anybody, and a dose half as large again would kill everybody exposed to it. This type of curve implies the existence of a threshold, below which the particular effect, in this case death, does not occur. The LD_{50} is not the same for all animals and a list of LD_{50} values is given in Table I. It is seen that generally the smaller the organism the larger is the dose required to kill it. The fruit fly requires 60,000 rads while the mouse only 600 rads. Man comes somewhere in between the dog and the guinea pig.

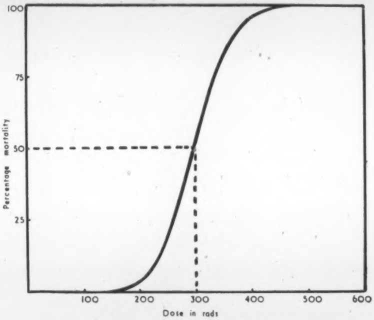

Fig. 1. *Sigmoid curve for lethal effects of radiation in man.*

TABLE I. LD_{50} FOR DIFFERENT ORGANISMS (RADS)

Mammals		*Other Organisms*	
MAN	300	Fish	700
Goat	240	Frog	700
Swine	250	Tortoise	1,500
Dog	280	Newt	3,000
Guinea Pig	430	Snail	10,000
Monkey	520	Yeast	30,000
Mouse	600	Fruit Fly	60,000
Rabbit	720	Amoeba	100,000
Rat	800	Paramecium	300,000

---

* Based on a lecture to the Liverpool and North Wales Branch of the Institute, given in Liverpool on January 8, 1959.

LONG TERM EFFECTS

If a dose which would have been lethal if given at once, is spread out over a long period, or is divided into fractions with intervals of no exposure between them, or if only part of the body is exposed, no deaths occur and often not even other acute radiation symptoms. It is believed that in such cases, as well as in the case of the survivors from a large single dose, the body managed to cope with the injury, that the repair mechanisms which always operate in the body took care of the damage.

Initially it was thought that those who survived the effects of radiations, recover completely without any residual effects. It turned out, however, that this was not true; some fraction of the injury remains unrepaired although its effect may be latent for many years. When it does appear, it may be in various forms such as cataract, leukaemia or cancer. For years it had been known that the miners in Schneeberg, in Germany, have been dying of cancer of the lung, but it was not until fairly recently that the cause of it was established, the inhalation of radioactive dust. Perhaps the most dramatic demonstration of the cancer inducing action of radiation was the case of the girls employed in the luminous watch industry. To make a watch luminous, a solution containing radium is painted on. This used to be done by hand and very often the girls would moisten the brush by putting it into their mouth. In this way, they accumulated large amounts of radium in their bones. The radiations given off resulted in various bone diseases, and, frequently, in bone cancer, from which many of them died.

Usually the symptoms occur at the organ exposed to the radiation. Thus, if the eye is exposed, cataract will frequently result. If the skin is repeatedly exposed to radiation, there occurs dermatitis, ulceration and eventually carcinoma; if the bone is irradiated the result is decalcification, fracture and bone sarcoma. The irradiation of the blood forming organs, such as bone marrow, results in anaemia, leukaemia and lymphosarcoma.

But apart from these localized effects there also appears to be another, more general effect, which manifests itself in a shortening of the span of life. This has not been, so far, proved in man but it has been definitely established in animals. The larger the dose, the younger the age at which the animals die; a small reduction in life span is found even for quite small doses of radiation. Although the cause of the shortening of life span is not yet definitely known, it is believed that it is the result of an acceleration of ageing by radiation. The injury produced by the radiation appears to have affected imperceptibly a number of body functions, thus bringing old age in prematurely.

GENETIC EFFECTS

All effects which occur in the individual exposed to the radiation are called somatic effects. Quite distinct from these are the genetic effects, which occur when the cells in the reproductive organs are damaged by radiation. Such damage involves a change in the genes, the entities which determine the characteristics of the descendants of the person exposed. In the vast majority of cases these changes, or mutations, are for worse, giving rise to a deleterious effect. This may be in the form of some defect in the make up of the offspring, sometimes appearing several generations later. Contrary to popular belief, these mutations result only extremely rarely in the birth of a monster. In the majority of cases they produce an impairment of some body function, which may be either serious, such as hydrocephaly, or trivial, such as baldness. Perhaps the most common result of genetic damage is a general debility, lower intelligence, less resistance to the strain and stress of life, and as a consequence of all this, a shortened life span. Here too, almost all our knowledge is based on experiments performed with animals.

RELATION BETWEEN EFFECT AND DOSE

So far the biological effects of radiations have been described in a qualitative manner. But it is the quantitative aspect that is of prime importance. How big a dose is required to produce a given biological effect? What is the relationship between dose and effect? I have mentioned before the sigmoid type of curve applying to acute effects; does the same apply to the late somatic and to genetic effects? Is there a threshold, a safe dose, or does the effect increase proportionately with the dose? We are particularly interested in the effects of small doses of radiation. There have been conflicting reports about the effects of small doses of radiation and claims have even been made that, far from producing damage, small doses may be beneficial, stimulating and even prolonging life. Under close scrutiny, however, these claims have not been substantiated. There is no evidence of any beneficial effects of small doses of radiation on living organisms.

On the other hand, there is no definite evidence of any harmful effects of small doses of radiation. It will take a long time before such evidence is accumulated and, in the meantime, all we can do is to look at the data obtained with large doses and try to extrapolate —or to be more honest—to guess, what the effect would be with small doses. For this purpose we have to look

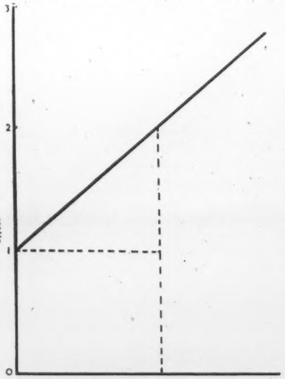

Fig. 2. *Linear relationship between effect and dose.*

into the relationship between effect and dose, for the various types of damage listed before.

The simplest of all appeared to be the problem of genetic damage. There has been general agreement among geneticists that the relation between the amount of genetic damage and the dose is not a sigmoid type but linear; this means that any increase in radiation causes a proportionate increase in the number of mutations. This type of relationship is illustrated in Figure 2 in which the vertical scale gives the damage (e.g. the number of mutations), and the horizontal scale the dose of radiation producing that damage. A linear relationship implies that there is no threshold, that even a very small increase in radiation level results in a small, but definite, increase in the damage. The point at which the line intersects the axis gives the natural incidence of mutations, due to causes other than radiation. If the value of this natural incidence were known, one could then work out the so called " doubling dose," the dose of radiation necessary to double the natural level of mutations. There is still considerable uncertainty about the value of the doubling dose in man; it is probably greater than 10 rads and smaller than 100 rads; the value accepted at present is 30 rads. This means that if the gonads of the whole population before the age of 30 (the average child-bearing age) were given a dose of 30 rads, then the total number of mutations would be doubled. It is believed that out of every hundred live births, one to four children are born with some congenital defect due to natural mutations. A doubling dose would thus mean that in every generation, up to one hundred million children would be born suffering from a genetic defect.

Apart from assuming a proportionality between effect and dose, geneticists also agreed that the effect would be the same whether the dose was given in a short time or was spread out over a long period. They also thought that it made no difference whether a small number of people received a large dose, or a large number of people received a small dose; what matters is the cumulative dose received by the whole population.

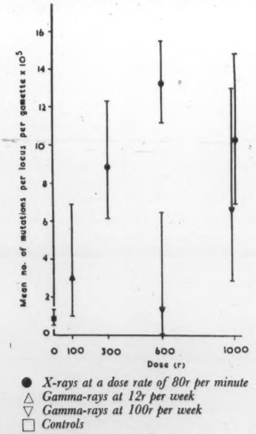

Fig. 3. *Mutation rates in mice as a function of dose for different rates.*

Most of these conclusions were based on experiments carried out with insects and animals, mainly mice. Recent experiments, however, have thrown some doubt on the validity of these assumptions. The results of large scale experiments with mice, carried out at Oak Ridge, are illustrated in Figure 3. In the early experiments the dose was given to the mice fairly rapidly and the experimental data appeared to fit a straight line. Recently, a larger dose was given and, surprisingly, the number of mutations resulting from it was, in fact, smaller than that obtained from a lower dose. The second surprise was that the same dose given at a lower rate, produced less mutations. Thirdly, it appears that in female mice fewer mutations are produced by the same dose than in male mice. These results show that even the genetic problem is much more complicated than it was thought, and that we still have a great deal to learn about it.

Even less is known about the laws governing the somatic damage. The main problem here is whether the relationship between effect and dose is linear, or of a sigmoid type, implying the existence of a threshold. If the first alternative were correct, then any increase in radiation level, however small, would result in some somatic damage to the population. If, on the other hand, there were a threshold, then only a sufficiently high dose would be harmful and below that dose we would be safe. I may sum up the situation by saying that the evidence is now about equal in favour of either hypothesis.

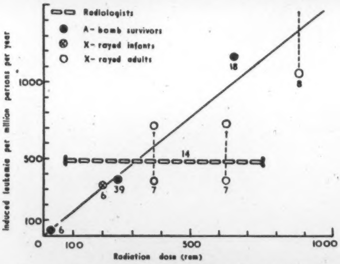

Fig. 4. *Induced leukaemia in man as a function of dose.*

As in the case of genetic damage, most of our information about somatic effects comes from experiments on animals, but there are also some data relating directly to man. The induction of leukaemia in man by radiation has been observed among the survivors of the Hiroshima bomb; among patients treated with X-rays for ankylosing spondylitis; and among children treated with X-rays for enlargement of the thymus. There is also some evidence that radiologists suffer more often from leukaemia than other medical practitioners. Although these effects have been established qualitatively it is not so easy to analyse them quantitatively, because the doses to which the people were exposed are not always known. The results of such analysis are shown in Figure 4 in which the incidence of leukaemia is plotted against the dose. It is seen that although the data are very scattered, they are consistent with a linear relationship, as shown by the line drawn. If this relationship is accepted, one can then work out the doubling dose for leukaemia. This turns out to be between 25 and 50 rads, which agrees surprisingly well with the value obtained for the genetic effect. This remarkable agreement between two entirely different processes suggests that they are, perhaps, based on the same mechanism. We know that genetic damage is caused by mutations in the germ cells. Similar mutations in somatic cells may result in somatic damage, for example in cancer which may be considered to be a normal cell gone wrong. This theory of point mutation is accepted by a number of scientists who use it to explain the origin of cancer. There are, however, a number of facts which do not fit in with this theory and the problem of carcinogenesis still remains unsolved.

Perhaps the least uncertainty concerns the shortening of life span as illustrated in Figure 5. The data for animals appear to fit in with a linear relation between the reduction of the span of life and the dose received, right down to very small doses. As mentioned, however, there is no evidence that the same applies to man.

Summing up, our knowledge is at present insufficient to assess the somatic harm from small doses of radiation. It may be that small doses are quite safe and nobody exposed to them would suffer any harm, but it is equally probable that even small doses will increase the chance of any person incurring cancer or other disease. When we are faced with such uncertainty, and since we are dealing here not with a few individuals but with the entire population of the world, there is only one prudent decision we can make, that until we know better we must assume the worst. We must organize our lives on the assumption that even a small increase in radiation level may result in some harm.

In order to make progress possible in the atomic age, we must know how great this harm might be under the most pessimistic assumption. From the figures already given we can work out the likely damage to result from a given dose of radiation on the basis of a linear relationship. If the whole population received a dose of 1 rad, then the chance of leukaemia would go up by 2×10^{-6} every year. Related to the world's population, this means that there would be 5,000 new cases of leukaemia every year and about 300 new cases of bone cancer. The life shortening of any individual would be quite negligible, about five days, but for the whole population this would add up to a loss of about 30,000,000 years. Major genetic defects would occur at a rate of 100,000 every year.

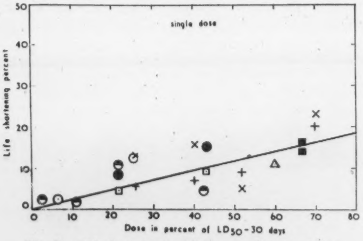

Fig. 5. *Life shortening by radiation as a function of dose.*

NATURAL BACKGROUND OF RADIATIONS

Let us now see what doses we are actually receiving from various sources. First we must deal with the natural background of radiations. This is made up of two parts, internal, from the radioactive substances contained in our body, and external, from the radiations in the environment. Each of these, in turn, is made of a number of components, which may act differently in various organs. The result of this is that the dose to the gonads, for example, is different from that received by the bones. Table II shows the composition of the radiations which an inhabitant of Great Britain may receive every year. The numbers are expressed in millirads. It is seen that the external radiations are made up of two sources: cosmic rays, the intensity of which varies with the altitude, being about ten times higher at an altitude of 20,000 ft., and the radioactive substances contained in the earth's crust. The amount of these varies with the type of soil, the largest content being in granite rocks. The walls of houses often add to the radiation. In cities, on foggy days, the activity may be many times higher than usual because the radioactive gases evolved from the soil are unable to escape.

TABLE II. DOSES FROM NATURAL SOURCES OF RADIATION (MILLIRADS PER YEAR)

Source	*To Gonads*	*To Bones*
External		
Cosmic Rays	28	28
Terrestrial radiation	47	47
Atmospheric radiation	2	2
Internal		
Potassium 40	19	11
Carbon 14	1·6	1·6
Radium	2	38
Total	100	128

The internal sources are made up of radioactive potassium and a small amount of radioactive carbon. In addition, our bodies contain a small amount of radium; almost all of it is contained in bones and since most of the radiation given off by radium is not penetrating it does not affect the reproductive organs.

All these sources together amount to an average of about 100 millirads per year to the gonads and 128 millirads to the bones. From the point of view of genetic damage only the first thirty years of life are important. The total dose from natural sources amounts, therefore, to about 3 rads (1/10th of the doubling dose). From the point of view of leukaemia, the dose to the marrow is of importance and in this case the whole life must be taken into account. Taking the average life span to be 70 years, we obtain a total dose to the bone of about 9 rads.

TABLE III. MEAN DOSE TO GONADS AND BONES FROM NATURAL EXTERNAL SOURCES

Region	*Population in millions*	*Aggregate mean dose millirads per year*
Normal regions	2,500	77
Granitic regions in France	7	190
Monazite regions:		
Kerala in India	0·1	830
Brazil	0·05	315

As already mentioned, the radioactivity from the soil may vary from place to place, depending on the type of substrate. There are, in fact, a few regions in France, Brazil and particularly in India, where the dose is much higher. However, the number of people living in these regions is quite small, as is seen from Table III. In the Kerala district in India, which contains a very large amount of thorium, there are only about 100,000 people. This region is of great interest since the people there form a practically isolated community, without much intercommunication with the outside world; it should, therefore, be possible to observe radiation effects in Kerala. A study with this aim in view has recently been started.

MAN-MADE SOURCES OF RADIATION

The natural background of radiations, which always existed, has been in recent years augmented by some man-made sources. These can be divided into two classes, military and non-military; this division being also based on the distribution of the additional sources of radiation.

The non-military sources arise from scientific and technical achievements and are the direct outcome of our striving for better health and greater comfort in life. They include luminous dials, shoe fitting devices, T.V. tubes, high altitude flying, the various uses of radiation in the atomic energy and other industries, and above all the medical uses of radiations. In fact, the largest addition to the natural background comes from one source, diagnostic X-rays. X-rays are the most direct and convenient method of diagnosing disease and so no wonder that their use in medicine has been increasing steadily. Over 15 million X-ray examinations are carried out in Great Britain every year. In the majority of these examinations, the dose given to the patient is very small, but they all add up, with the result that we are now receiving from X-ray investigations a dose nearly as big as that from the natural background. This fact was not realized until quite recently, and it arose from the concern of the public with the fall-out from nuclear test explosions. The committees which were set up to investigate the fall-out, discovered that a much greater hazard arises from medical X-rays. Since this discovery was made, steps have been taken to reduce this hazard. It is possible to cut down considerably the dose from diagnostic X-rays without affecting the benefits from X-ray examinations. This can be done by slight changes to the X-ray machines, improved shielding and more care during the examination. In some cases it is also possible simply to reduce the number of X-ray photographs taken. All these measures are now being implemented and the whole situation is carefully watched.

Apart from diagnostic uses, X-rays are also employed in treatment of disease. In most cases this treatment is for cancer, when the prognosis is very bad, and the saving of life by radiotherapy has, of course, priority. In any case, this source adds only very little to the dose important from the genetic point of view.

Compared with the medical uses of radiation, the other man-made sources are very small indeed, but on general principles they should be avoided if possible. Table IV lists the contributions from various man-made sources.

TABLE IV. GONAD DOSE FROM MAN-MADE SOURCES (MILLIRADS PER YEAR)

Source	*Dose*
(Natural)	(100)
Medical	
(*a*) diagnostic	20–150
(*b*) therapy	1–30
(*c*) internal	less than 1
Occupational	
(*a*) Atomic Energy Authority	0·1
(*b*) Industry	about 2
Various sources	
(*a*) luminous watches	1
(*b*) shoe fitting	0·1
(*c*) T.V. sets	less than 0·1
(*d*) high altitude flying	very small

The radiations resulting from the testing of nuclear weapons belong to a different category, because the benefits are not so obvious—in fact they are denied by some people—and because they affect everybody and not only the people who employ them. When a nuclear weapon is exploded in the air, the radioactive fragments are carried up high into the air, but eventually they are deposited on the ground. This deposition may occur as local fall-out, within a few hundred miles from the explosion, and as global fall-out. Since tests of large bombs are usually carried out far from inhabitated places, we are mainly interested in the global fall-out. In most tests the radioactivity is initially fed into the stratosphere, and it takes several years before it descends again. During this time most of the radioactivity has decayed but two radioactive substances with long half lives remain: Sr^{90} and Cs^{137}. They differ in their physical and biological properties; strontium concentrates in bone and sends off only β-rays, consequently it is not a genetic hazard but only a somatic hazard. Caesium, on the other hand, is a genetic hazard but contributes little to the somatic damage.

Since test explosions occurred mainly in the northern hemisphere, the deposition of activity is not quite uniform all over the world. Figure 6 shows the distribution of strontium on the ground during 1956 and 1957. It is seen that most of it occurred around a latitude of 30° North; it was much less in the southern hemisphere, but it so happens that the majority of the world's population lives in the region of high deposition of activity. The β-rays from the caesium on the ground give rise to an external irradiation of all living beings, but in addition, there is an internal source of irradiation.

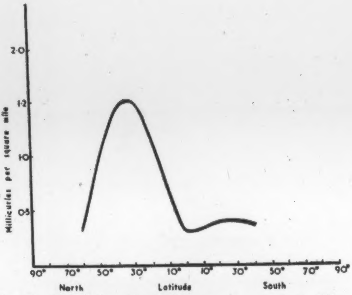

Fig. 6. *Distribution of strontium on the ground at different geographical latitudes.*

The radioactive substances are incorporated into plants and find their way into our bodies, either directly with vegetable food or indirectly when we drink milk or eat meat from animals which grazed on radioactive plants. It is possible to analyse the activity in our bodies by means of scintillation counters and pulse analysers. Figure 7 shows the result of an analysis of an inhabitant of Great Britain. The first peak shows the amount of padioactive potassium which we always had; the second reak is of radioactive caesium which only appeared since bomb tests started. Strontium cannot be detected in this way but it is found by ashing the bones of people who died in recent years. Considerable amounts of strontium have been found in our teeth and some animals show a very large increase of strontium in their bodies.

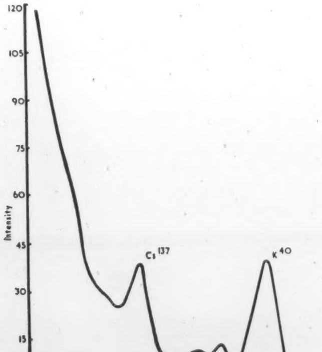

Fig. 7. *Analysis of radioactive content in man, showing presence of caesium—137.*

From such measurements it is possible to estimate the dose which we are receiving from test explosions and the number of casualties under different assumptions. These figures are given in Table V, which is taken from the recent report of the United Nations Scientific Committee on the effects of atomic radiations.

TABLE V. POSSIBLE RADIATION DAMAGE DUE TO FALL-OUT FROM WEAPONS TESTS (NUMBER OF CASUALTIES PER YEAR)

Type of damage	*If tests stopped in 1958*	*If tests continued indefinitely*	*Natural radiation*
Major genetic defects	100-4,000	500-40,000	25,000-1,000,000
Leukaemia	400-2,000	5,000-60,000	15,000 - 25,000
Bone cancer	70 - 900	1,000-25,000	1,500 - 5,000

CONCLUSION

In the list of hazards which we have to face in the atomic age, one important item has been left out, that arising from the atomic energy industry. Britain's economy is based on the availability of nuclear power, and it is expected that in the course of time other countries too will develop their nuclear power programmes. We have, therefore, to envisage a large number of nuclear reactors all over the world, a well as nuclear powered ships, submarines and, perhaps, other means of transportation. This may bring with it two types of hazard. One is from accidents to reactors, like that which happened at Windscale in 1957. By learning from experience and by proper design of reactors, it should be possible to reduce considerably the probability of an accident, although it can never be eliminated completely. The second is the disposal of radioactive wastes from nuclear reactors and the polution of water and air with radioactivity. At the moment, the amounts we have to deal with are relatively small, but in the course of time we may find it impossible to provide the necessary safeguards, unless such expensive measures are taken that they will increase considerably the cost of nuclear fuel. Fortunately, there appears to be a solution to this problem. We know now that it may be possible to produce nuclear power by fusion instead of by fission, and this new method does not involve the production of large amounts of radioactivity. It is, therefore, possible that we shall have the benefit of nuclear power without having to worry unduly about radiation problems.

Nevertheless, the ever increasing use of radiations in medicine, agriculture and industry is bound to lead to a slight increase in the level of radiation. These uses will, however, confer on us definite advantages and consequently the possible harm must be balanced against the definite benefits.

Finally, the question arises about the possibility of protecting against damage from radiation. To achieve this we must first know a good deal more about the action of radiation on living matter. We can, however, already see some glimpses of the future possibilities. It has been found, for example, that some chemical substances have the property of protection against the acute effects of radiation; this means that a person who has taken such a substance *before* exposure could receive a somewhat larger dose of radiation and remain alive than would a person without this protection. So far it has been tried only with animals and there is still a long way to go before it can have any practical use. A more promising approach is the transplantation of bone marrow. It was found that animals exposed to a large dose of radiation survive, if *after* irradiation, bone marrow from another animal is transplanted so that it can take place of the one destroyed by the radiation.

Research in this field has started only in recent years and it is too early to assess it, but judging from the progress made in other fields of science we are entitled to hope that in the course of time, we shall learn how to counteract the effects of radiations. The menace of radiation which looms so large in our minds may well be removed, enabling us to reap the benefits of scientific achievement without doing harm to ourselves and to future generations.

REFERENCES

Fig. 3. W. L. and L. B. Russell. Paper 897 of the *Second Conference on the Peaceful Uses of Atomic Energy.*

Fig. 4. Paper by E. B. Lewis. *Science*, **125**, 965, 1957.

Fig. 5. *Report of the United Nations Scientific Committee on the Effects of Atomic Radiations*, 1958.

Notes and News

Thirty-ninth Annual General Meeting

Notice is hereby given that the Thirty-ninth Annual General Meeting of The Institute of Physics will be held at 5 p.m. on Tuesday, July 7, 1959, at the Institute's House. Attendance is limited to Fellows and Associates of the Institute. The business to be conducted is the consideration of the Board's report, the accounts and balance sheets for 1958, the declaration of the election of the Honorary Officers and other members of the Board nominated, and the election of auditors. A copy of the annual report and accounts is printed in this issue of the *Bulletin*. Further copies will be sent on request.

F. A. Vick,
April 10, 1959. *Honorary Secretary.*

Nominations to the Board

In accordance with Article 47 of the Articles of Association of the Institute, notice is hereby given that the Board has nominated the undermentioned persons to fill the vacancies stated which will occur on September 30, 1959.

The Ordinary Members nominated were selected by ballot from a list of suggestions made by Branch and Group Committees and members of the Board.

Attention is directed to the terms of Article 48 which reads as follows: "After the notice (*i.e. this notice*) mentioned in the last preceding Article any five Members (i.e. Fellows and Associates) may nominate within two weeks of receipt by them respectively of such notice, but not later, any other duly qualified person as a candidate for election to any one or more of the said Offices by depositing such nomination in writing at the Registered Office of the Institute together with the written consent of the nominee to accept office if elected. No member may nominate more than one candidate in any year." Ballot papers will be circulated in due course to Fellows and Associates and the result of the ballot will be announced at the Annual General Meeting on July 7 next.

President :

*Sir George Thomson, M.A., LL.D., Sc.D., Hon.F.Inst.P., F.R.S., Nobel Laureate, Master of Corpus Christi College, Cambridge.

Vice President (*one vacancy*) **:**

J. M. A. Lenihan, M.Sc., Ph.D., A.M.I.E.E., F.Inst.P., Regional Physicist, Western Regional Hospital Board, Glasgow.

Hon. Treasurer :

*J. Taylor, M.B.E., Ph.D., D.Sc., F.R.I.C., M.I.Min.E., F.Inst.P., Director, Imperial Chemical Industries Ltd.

Hon. Secretary :

*Professor F. A. Vick, O.B.E., B.Sc., Ph.D., A.M.I.E.E., F.Inst.P., Professor of Physics, University College of North Staffordshire.

Ordinary Member (*two vacancies*) **:**

V. E. Cosslett, M.Sc., Ph.D., F.Inst.P., Lecturer in Physics, Cavendish Laboratory, Cambridge.

L. Rotherham, M.Sc., F.I.M., F.Inst.P., Member of the Central Electricity Generating Board, London.

F. A. Vick,
April 10, 1959. *Honorary Secretary.*

** For re-election to the same office.*

The nominations for President, Honorary Treasurer, Honorary Secretary are those of the present officers. The Board's nominees for Vice-President and Ordinary members of the Board have not previously served in these capacities.

Vice-President : Dr. J. M. A. Lenihan

Dr. Lenihan is a graduate of the Universities of Durham and Glasgow. Immediately after the war he was appointed to the staff of the Physics Department of the University of Glasgow and subsequently became the first hospital physicist to the Western Infirmary, Glasgow. A central research and service organization for physics was later set up to cover all the hospitals of the West of Scotland and Dr. Lenihan was appointed to take charge of this as Regional Physicist to the Western

Regional Hospital Board, a post which he still holds. Elected to Associateship of the Institute in 1940 and to Fellowship in 1945, Dr. Lenihan has been Honorary Secretary and Chairman of the Scottish Branch and has served on the Board as an Ordinary member. He is Chairman of the Advisory Committee of the Institute's Journals and is also Chairman of the Scottish Joint Committee for National Certificates in Applied Physics.

Ordinary members :

Dr. V. E. Cosslett

Educated at the University of Bristol, the Kaiser Wilhelm Institute, Berlin, and University College, London, Dr. Cosslett was a Lecturer in the University of Oxford during the war and an I.C.I. Research Fellow at the Cavendish Laboratory, Cambridge, in 1946-49. Since 1949 he has been a University Lecturer in Physics at Cambridge. Dr. Cosslett is known internationally for his work in electron microscopy.

Becoming an Associate of the Institute in 1939 and a Fellow in 1942, Dr. Cosslett has been Honorary Secretary and Chairman of the Institute's Electron Microscopy Group. He is also the Secretary of the International Federation of Electron Microscope Societies.

Mr. L. Rotherham

Mr. Rotherham graduated in physics at University College, London, and after some years with the Firth-Brown Research Laboratories, Sheffield, Mr. Rotherham was appointed Superintendent of the Metallurgy Department of the Royal Aircraft Establishment, Farnborough. Subsequently, after a short period as Chief Metallurgist to the Ministry of Supply, he joined the United Kingdom Atomic Energy Authority, eventually becoming Director of Research and Development of the Industrial Branch. Last year Mr. Rotherham became the Member for Research of the Central Electricity Generating Board.

Mr. Rotherham joined the Institute as an Associate in 1937 and was elected to Fellowship in 1941. He is a member of the Finance Committee. He is also the author of one of the monographs published in the " Physics in Industry " series, *Creep of Metals.*

The Institute's Finances

The consolidated accounts on pp. 86-87 of this issue of the *Bulletin* are issued for the convenience of those members who wish to have a simple general picture of the Institute's financial affairs as a whole. These combine the formal accounts of the Institute proper (on pp.109-110), and its Endowment Trust Fund (on p. 111) through which the scientific and educational work is carried out. The formal accounts will be presented for adoption at the Annual General Meeting on July 7 next.

Before allowing for the continued writing off of the expenditure on the alteration and adaptation of the House, providing for depreciation and allowing for the premium of the leasehold redemption policy, there is a deficit on the year's working of £28, compared with an estimated deficit of £1,000, as mentioned in the June *Bulletin* (p. 133). The final deficit of £1,728 is fortunately £1,107 less than the estimated one. Although individual items have varied a little from the estimates, the total expenditure was only £1,153 more than the approved amount of £58,100. All the items on the income side are better than expected, the total being £2,062 more than the anticipated income.

It was only possible to keep the deficit on the year's working down to the figure mentioned by the closest control on expenditure, and by being as economical as possible throughout the year. Indeed, these accounts show once more how necessary it was to arrange to raise the members' subscription rates and the retail price of the journals and thus prevent further deficits. The slenderness of the Institute's reserves continues to give the Board anxiety and it has before it various proposals for obtaining the necessary additional financial support that will enable the Institute's work to grow in the way in which it is sure members desire.

THE ANNUAL DINNER

Park Lane Hotel, Piccadilly, London,

May 5, 1959

Applications for tickets for the Annual Dinner on May 5, 1959, should be sent in as soon as possible.

The principal guests are Sir Keith Murray, Chairman of the University Grants Committee, and Dr. J. B. Conant, lately American Ambassador to the Federal German Republic and formerly President of Harvard University.

Tickets (exclusive of wines) are 40s. each. Graduates under the age of 25 years, and Students of the Institute may have either one or two tickets at 30s. each.

THE INSTITUTE OF PHYSICS

CONSOLIDATED INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1958

1957 £		£	*1957* £		£
20,303	To Production and distribution of publications (excluding cost of labour and overheads)	18,731	*34,769*	By Receipts from publications	33,532
19,206	,, Salaries and National Insurance and staff superannuation	21,567	*8,543*	,, Receipts from advertisements in Journals	7,828
6,278	,, Rent, rates, lighting, cleaning and maintenance	5,256	*2,833*	,, Receipts from sale of book stock	—
1,311	,, Board and Committee meetings expenses and travelling expenses	1,360	*15,013*	,, Members' subscriptions, entrance and application fees	15,898
2,395	,, Printing and stationery	2,838	*640*	,, Dividends and interest	1,326
1,806	,, *Bulletin* (net)	1,819	*157*	,, Donations received by Trust Fund	—
2,452	,, Postage and telephone	2,919	*231*	,, Non-Members' Conference fees	319
2,702	,, Branches and Groups	2,826	—	,, Income Tax recovered	259
1,156	,, Conferences and Conventions (net)	291	*386*	,, Deficit for the year before depreciation, etc.	28
540	,, Educational work, examinations (net) and special reports	487			
1,680	,, Miscellaneous expenses	859			
300	,, *Science Abstracts* basic payments	300			
60,129		59,253			
2,443	*Less* : Increase in stock of publications	63			
£62,572		£59,190	*£62,572*		£59,190
386	To Balance brought down	28	*2,964*	By Final deficit for the year	1,728
378	,, Amount written off expenditure on alterations, etc., to House	378			
1,215	,, Depreciation of furniture, fittings and office machinery	337			
985	,, Leasehold Redemption Policy	985			
£2,964		£1,728	*£2,964*		£1,728

THE INSTITUTE OF PHYSICS

CONSOLIDATED BALANCE SHEET, 31 DECEMBER, 1958

1957 £		£	£
4,774	LIFE MEMBERSHIP FUND		4,722
22,241	RESERVE FUND		23,364
	CURRENT LIABILITIES :—		
	Subscriptions to 1959 Journals	12,707	
	Payments from members in advance	613	
10,529			13,320
5,843	For expenses including production of publications		5,679
19,743	A.S.T.M. File Fund		22,795
£63,130			£69,880

1957 £		£	£
	FIXED ASSETS :—		
	FURNITURE, FITTINGS AND OFFICE EQUIPMENT, at cost	7,278	
	Less : Depreciation	6,265	
910			1,013
	ALTERATION, IMPROVEMENT AND ADAPTATION OF PREMISES, at cost	10,289	
	Less : Depreciation	4,908	
5,759			5,381
	CURRENT ASSETS :—		
2,494	STOCK ON HAND, at valuation		2,670
6,749	DEBTORS AND AMOUNTS PAID IN ADVANCE		6,060
31,089	INVESTMENTS, at cost *(Estimated market value, 31 December, 1958, £30,135)*		31,089
7,880	LEASEHOLD REDEMPTION POLICY		8,865
7,448	BANK BALANCES AND CASH IN HAND		12,239
801	ENDOWMENT TRUST FUND		2,563
£63,130			£69,880

Correspondence

From industry to technical education

Dr. Crank in his article may have painted a fair picture of average conditions in advanced technical colleges, but if that is so, then my department would appear to be at the far end of a fairly long standard deviation. As his article may have the result of making it even more difficult to attract good staff, I feel it is important to show just how large the variation in conditions can be. I shall take his letter point by point.

1. Sandwich courses for the diploma in technology. We offer the thick sandwich (two years in college, one year in industry, one year in college) and think it educationally preferable. It certainly means that our time-table can approximate much more closely to an orthodox university time-table and that there can never be any question of end-on sandwich courses which occupy four terms in the year. The comparison of a thin sandwich course with medical students is in any case quite fallacious, since the walking of medical wards is merely an extension of laboratory work with lectures going on all the time. A better comparison is between the Houseman's year and the industrial year of the thick sandwich course.

2. Conditions of an Assistant (Grade B). The number of teaching hours is fifteen, of which not more than three are lectures. The others are laboratory supervision and tutorials. The salary scale for a man with a good honours degree and two years' postgraduate experience is £850–£25–£1,225 plus London allowance and now plus 5 per cent. As far as this department is concerned a candidate with lesser qualifications is very unlikely to get the job, so that our effective minimum now is £930. This is £230 above the corresponding university salary.

3. A Reader's teaching hours are eight and at least two of these will be assigned to the supervision of postgraduate research.

4. Nobody in this department gives more than four to five lectures a week, i.e. one quarter to one third, and not a half to two thirds of total.

5. " By and large staff are in the college for only three-quarters of the year." Time available for research must include not only the interrupted periods available in term time, but also long uninterrupted periods in the so-called holidays. It is of course true that not every lecturer spends virtually the whole summer on research, but since advancement will become increasingly dependent on successful research as well as teaching, there is now every inducement to do this. To shorten the holidays would make research virtually impossible. How is this problem solved in colleges with end-on courses ?

6. Money for research. Yes, the present procedure is irksome, though not as irksome as outlined in the article. But what about D.S.I.R. grants ? A lecturer was appointed here last September, an application was in by October 1 and the grant came through before Christmas.

7. Expenses. The situation with us is certainly much better than the one outlined in the article.

To sum up. I don't want to give the impression that everything is perfect. Far from it. We are short of space, short of staff, short of equipment. But all that will come. I have just made up an itemized list of equipment needed between now and 1963, where I feel a crystal ball would have been helpful. I could go on airing some petty grievances that I think are important when I wake up at 3 a.m. and I could air some bigger ones that really *are* important. But all this is unimportant compared with the fact that we are engaged in a task that is supremely worth doing and that can be seriously harmed by indiscriminate criticism.

L. R. B. ELTON (*Fellow*)
Battersea College of Technology.

Whilst the substance of most of Dr. Crank's forthright and provocative article " From Industry to Technical Education " will command general support amongst teachers in technical education, two of his points seem to me to call for comment.

Lest any prospective entrant to technical education should imagine that, as an Assistant Lecturer Grade B, he would automatically be offered a weekly timetable of about ten hours lecturing plus six hours laboratory demonstration, it should be made clear that, even in colleges in which research work is strongly encouraged, a teacher is frequently expected to make out a case for the granting of up to six hours time for research by producing evidence of his past achievements. As a Grade B Assistant he would be expected to work to a weekly teaching timetable of about twenty-two hours, of which not more than six could be devoted to research work. In the first instance he would probably have to show, by his efforts outside twenty-two actual teaching hours, that he was worthy of a concessionary allowance of up to six hours in later sessions. Similar conditions might well apply to Lecturers and Senior Lecturers except that the total hours would be somewhat less. In general it would appear that for the first twelve months after entry into the profession a Lecturer of any grade would be fully occupied in preparing his teaching work, and attending to his other duties.

The very sweeping statements concerning the superior abilities and outlook of the " industrial man " are unnecessarily harsh towards the established teacher. To generalize that " the industrial man will be much more at home and successful with advanced and postgraduate classes " is just as much nonsense as that the established teacher " has little to offer to advanced students." In any go-ahead department fresh opinions, new methods and wider experience are always welcomed by the staff, and most of all by the Head of the department lucky enough to acquire such an influx. Whether these attributes are obtained by work in other colleges, in industry, in universities or Research Associations, or even in certain cases in H.M. Forces, is frequently unimportant. Although there are many instances in which industrial experience is most desirable, there are otl when experience in another college, for example, would be preferred. The inference that one has only to spend ten years away from the invigorating life of industry to become dead from the neck up is not likely to be kindly received by those who have spent many years attempting to build up worthwhile standards in technical education, and so attract people like Dr. Crank to wish to assist in maintaining them.

There is a current fashion to place too much emphasis on research work and industrial experience, it being forgotten that, whilst both have their undeniable place in technical education, the teaching and guidance of students should be paramount. Ability to impart knowledge to encourage the learning process in others is seldom innate, and it is not necessarily fostered in industry.

These matters apart, Dr. Crank is to be complimented upon putting his finger on many of the failings of the present system, whilst pointing to the exciting prospects that lie ahead.

A. G. Peace (*Fellow*)
North Staffordshire Technical College.

Dr. Crank comments as follows :

I am grateful for the comments made by the Heads of the Physics Departments of Battersea College of Technology and North Staffordshire Technical College. On several points these two contributions cancel each other and the main conclusion seems to be that there is a wide range of conditions of service. I suspect, however, that the conditions to which I refer are probably more common at the moment than the much more attractive ones at Battersea, but we can hope for a not too gradual change in that direction.

In passing, may I say that the analogy between the thin sandwich course and the walking of wards during medical training came, not from me, but from the Minister of Education and if Dr. Elton wishes to quarrel with him, who am I to interfere ?

Finally, I should like to make it quite clear that I in no way under-estimate the efforts of those who have been at work in technical education for years, attempting to build up worthwhile standards. I am confident that the majority of those who have been so engaged will be the first to recognize the contribution which research work and industrial experience have to make to education and *vice versa*.

Reviews of Books

ATOMIC PHYSICS AND HUMAN KNOWLEDGE

By Niels Bohr

London : Chapman and Hall Ltd. Pp. viii + 101. Price 32s.

IN SEARCH OF REALITY

By Viscount Samuel

Oxford : Basil Blackwell. Pp. ix + 229. Price 28s. 6d.

From lectures given in the years 1932-1938, 1949 and 1954-1957, Niels Bohr conveys his appreciation of wholeness in atomic processes. The first three essays are concerned with biological and anthropological problems. In the fourth is given a discussion with Einstein on epistemological problems of quantum physics. The importance of comprehending fully the circumstances under which evidence is obtained is further brought out in the more recent group of articles concerned with unity of knowledge, atoms and human knowledge and physical science and the problem of life.

Each of the seven essays is a facet of the world picture to which his studies have led a distinguished physicist. The idea that man and his environment must be considered as a whole is also central in Viscount Samuel's search for reality. The twelve chapters range over philosophical questions such as : what is reality, what is now known about life and the mind, the role of the institutions in which the customs of civilization are embodied, religious questions and their relation to reality. Here also much use is made of an outlook stemming from modern physics ; one of the three appendices has a letter from Einstein to the author.

The two books are complementary. Taken together they may well reflect the growing community of interest and agreement between men of widely different backgrounds.

R. L. Brown.

ELECTRON PHYSICS AND TECHNOLOGY

By J. Thomson and E. B. Callick

London : The English Universities Press Ltd. Pp. xiv + 527. Price 50s.

I find it difficult to know for what kind of reader this book is intended. Even the publishers do not seem to know—they describe it in one place as a standard work for professional physicists and engineers and elsewhere as a book designed for an Honours student ! I cannot believe that either category of reader will find it satisfactory. It is difficult to avoid the impression that the book was originally intended as an account of the design and construction of microwave and other special purpose vacuum tubes, and that the sections dealing with electron physics have been added as an afterthought. I certainly hope that no student will ever have to rely on this book for his knowledge of physical electronics. In spite of the sentiments expressed by the authors in their preface, and by the General Editor of the series in a foreword, that a thorough grasp of the physical principles involved is an essential preliminary to a study of technology, the material they have provided for this purpose is most unsatisfactory.

It is unsatisfactory in its choice of topics : for example van der Waal's equation and the operation of a McLeod gauge are explained, but Planck's constant is introduced without any explanation at all, and " quantum " is used merely as an adjective to describe quantities such as efficiency, many of the diagrams in this section are ludicrously inadequate (for example, one purporting to show the arrangement of atoms in a body-centred cubic lattice), and in the treatment of, for example, semiconductors formulae are quoted without any attempt to explain their physical meaning or that of the concepts upon which they are based (e.g. the equation for the Fermi-Dirac distribution). Indeed, far from being a useful introduction this is just the type of superficial treatment against which students should be warned. It is just sufficiently plausible to lull them into feeling that they know something about the subject without giving them any real understanding at all of the fundamentals of the subject.

If, on the other hand, the reader can tolerate this sort of thing long enough to get past the first part of the book, he will find an adequate enough account of the rather more specialized types of thermionic valve. There are also chapters on the materials used and on details of design which, in marked contrast to those in the earlier section, are excellently illustrated. The chapters on valve construction are not entirely above suspicion, however. It is, for example, stated that a rotary vacuum pump cannot pump water vapour.

There are several misprints and, rather strangely in a book supposed to be written for Honours students (or even more strangely in a standard work), there are very few references to other published work, and such references as are given are only to textbooks and are never to original papers. It is not, perhaps, surprising that there are no references at all in the section in electron physics !

A. E. De Barr.

HANDBOOK OF PHYSICS

Edited by E. U. Condon and Hugh Odishaw

New York : McGraw-Hill Book Company Inc. ; London : McGraw-Hill Publishing Co. Ltd. Pp. xxvi + 1504. Price 194s.

This Handbook published in 1958 was revised by the contributors in galley proof in an effort to make it as up to the minute as possible. This was a praiseworthy attempt to overcome the tendency of books on rapidly growing subjects to become out-of-date even while in the press. The editors have been defeated by the vastness of the field of physics and the single volume they have produced has over 1500 pages and weighs over 2½ kilograms, so that the title of Handbook is something of a misnomer. A handbook is not an encyclopaedia, so it is to be expected that the articles, which are by men eminent in the respective fields, are highly condensed and often presuppose a considerable knowledge of the subject. But given such a background on the part of the reader, the articles are all excellent. To single out some among many, the sections on Fundamental Constants of Atomic Physics, Molecular Optics and on Conduction in Metals and Semi-conductors are noteworthy. The work as a whole is not innocent of a tendency to flatter the specialist by reminding him how much he already knows. For such it will be salutary to reflect on the versatility of the senior editor. It will astonish even those who know him as a physicist of wide learning, to see that no less than seventeen of the articles running to some 200 pages are from his own pen.

A handbook is not a dictionary and to use the index as if it were, is to be disappointed. It may be said that the index is the weakest part of the book, in that many familiar subjects although found in the text do not appear in the index. For example Wien's displacement law is not indexed, but Planck's law is, also the Stefan-Boltzmann law, and reference to either of these reveals a paragraph on Wien's displacement law suitably italicized. For the most part it is true that one can usually find what one needs if one knows enough to look for it in the proper place, but there is too much chance inherent in the search.

This criticism apart, the editors are to be congratulated on a monumental achievement, which many physicists will find valuable, although fewer will find the price within their means. A. M. Taylor.

UNIVERSITY MATHEMATICS

By Joseph Blakey

Glasgow: Blackie & Son Ltd. Pp. v + 581. Price 35s.

The first edition of this book was extremely popular with students. There is every reason to expect the second edition to be equally well received, though some teachers and lecturers will doubtless hesitate to recommend it unreservedly, as they have always done. The book is intended for a first year course in pure mathematics at any university though it is related particularly to Part I of the London General degree. Chapters on spherical trigonometry and moments of inertia have been added to keep in touch with the revised regulations for that degree.

It is too much to expect that the treatment in a book of this kind will please everyone. The reviewer, for example, would prefer to introduce the exponential function as being one whose rate of change is always equal to the value of the function and to deduce its other properties accordingly. More use could be made of MacLaurin's series by applying it in the derivation of the binomial expansion and the logarithmic series. It seems a pity to miss the opportunity of introducing Newton's iterative formula for the improvement of a root of an equation as an example in the use of Taylor's series. Two other criticisms are that curve sketching is dismissed in half a page and it is only late in the book that odd and even functions are distinguished. It is a good thing that we are told what a " Corleil differential coefficient " is as otherwise the reviewer for one would not have known.

These are largely matters of personal preference, however, and in stating them the reviewer has no wish to obscure the real value of the book. It is a most attractive and readable presentation of the vital subject matter shorn of distracting trimmings. It is this feature which will doubtless commend it to the students, particularly the physicists, engineers and others whose interest lies in mathematics as a useful tool rather than as a subject having an intrinsic importance of its own.

J. Crank.

Forthcoming Institute Meetings

Date	*Place*	*Speaker*	*Title*	*Time*	*Branch or Group*
April 16	**Liverpool** The University	Dr. N. Kurti, F.Inst.P., F.R.S. (*University of Oxford*)	**Nuclei at very low temperatures**	7.00 p.m.	Liverpool and North Wales
April 17	**Birmingham** University Union		**Branch Annual Dinner**	7.00 p.m.	Midland
April 17 and 18	**Leeds** The University		Spring Conference on **Clay minerals and biological fibres.** The first session will be preceded by the Group Annual General Meeting		X.Ray Analysis
		Visitors are welcome	but registration is necessary.		
April 21	**Stoke** British Ceramic Research Association	Mr. A. Dinsdale, F.Inst.P. (*British Ceramic Research Association*)	Visit to laboratories followed by a talk	2.30 p.m.	Midland
April 24	**Aberystwyth** University College of Wales	Dr.C.E.Wynn-Williams (*Imperial College of Science and Technology, London*)	**An introduction to electrical logic**	5.15 p.m.	South Wales
May 1	**Weymouth** South Dorset Technical College	Dr. Joyce Billing	**The structure of the stars**		South Western jointly with I.E.E. Southern Centre.
May 5	**London** Park Lane Hotel		**Institute Annual Dinner** (see page 85)	7.00 for 7.30 p.m.	
May 8	**London** Royal Society of Arts		An all-day Symposium on : **Reviews of recent developments in spectroscopy**	10.30 a.m.	Applied Spectroscopy
		Dr. L. F. H. Bovey, A.Inst.P. (*Atomic Energy Research Establishment, Harwell*)	**Atomic spectroscopy**		
		Prof. W. C. Price, F.Inst.P., F.R.S. (*King's College, London*)	**Molecular spectrocopy**		
		Mr. W. Ramsden (*Aluminium Research Laboratories (Gt. Britain) Ltd.*)	**Spectrochemical analysis**		
		Dr. A. C. G. Menzies, F.Inst.P., F.R.S.E., (*Hilger & Watts Ltd., London*)	**Instrumentation**		
		Dr. D. J. E. Ingram, F.Inst.P. (*University of Southampton*)	**Magnetic resonance at radio and micro-wave frequencies**		
		Dr. D. Z. Robinson (*Office of Naval Research, U.S. Embassy*)	**Recent developments in the United States**		
May 14	**Liverpool** The University	Mr. J. M. Craddock (*Meteorological Office*)	Branch Annual General Meeting followed by a lecture on : **Long range weather forecasting**	7.00 p.m.	Liverpool and North Wales

The Register

ELECTIONS TO MEMBERSHIP

THE FOLLOWING ELECTIONS WERE MADE BY THE BOARD ON MARCH 3, 1959

An asterisk (*) indicates transfer from another grade

FELLOWS (18)

*Aitchison, Ronald Ernest, M.Sc., Associate Professor of Communication Engineering, University of Sydney.

*Aldred, Francis Henry, B.A., Technical Manager, Morgan Refractories Ltd., Wirral, Cheshire.

*Beynon, John Herbert, B.Sc., Physics Group Leader, Imperial Chemical Industries Ltd., Dyestuffs Division, Manchester.

Bigg, Philip Harold, B.Sc., Senior Principal Scientific Officer, National Physical Laboratory, Teddington, Middlesex.

*Colmer, Frederick Charles William, M.A., Director of Research and Development, Central Electricity Generating Board, London.

*Crangle, John, B.Sc., Ph.D., Lecturer, University of Sheffield.

*Cunliffe, Arthur, B.Sc., A.R.C.S., Ph.D., Lecturer, University of Hull.

Fowler, John Francis, M.Sc., Ph.D., Principal Physicist, King's College Hospital, London.

Gates, Benjamin George, B.Sc., Ph.D., Deputy Chief Scientist, Research and Development, Department of Supply, Australia.

Gledhill, John Alan, Ph.D., Professor and Head of Physics Department, Rhodes University, Grahamstown, S. Africa.

*Jones, William Mervyn, B.Sc., D.Phil., Lecturer, University College of Wales, Aberystwyth.

Knott, George, M.A., Lecturer, Welsh College of Advanced Technology, Cardiff.

*Leech, John Watson, B.Sc., Ph.D., Lecturer, Queen Mary College, London.

*Roscoe, Robert, B.Sc., Ph.D., Senior Lecturer, King's College, Newcastle-upon-Tyne, University of Durham.

Sriraman, S., M.A., M.Sc., Ph.D., Lecturer, Annamalai University, India.

*Tapper, Edward William, B.Sc., Head of Physics Department, Dulwich College, London.

*Taylor, Herbert Eric, M.A., Ph.D., Technical Manager, Parkinson and Spencer Ltd., Halifax.

*Woodroofe, Ernest George, B.Sc., Ph.D., Director, Unilever Ltd., London.

ASSOCIATES (64)

Anderson, Edward Gibson, B.Sc., Assistant Engineer, Central Electricity Research Laboratories, Leatherhead, Surrey.

Armstrong, William Edward, B.Sc., Physicist, North Thames Gas Board, London.

Asher, Leonard, B.Sc., Senior Engineer, De Havilland Propellers Ltd., Stevenage, Herts.

*Barron, Kenneth, M.Sc., Scientist, National Coal Board, Mining Research Establishment, Isleworth, Middlesex.

Barton, William Horace, B.Sc., Senior Science Master, Chadderton Grammar School, Lancashire.

*Bennett, John Edward, B.Sc., Ph.D., Research Physicist, Shell Research Ltd., Chester.

Bowen, Leonard Oswald, B.E., M.Sc., Lecturer, New South Wales University of Technology.

Brakspear, John Nicholas, B.Sc., Head of Quality Department, Mullard Simonstone Works, Burnley, Lancashire.

*Burd, Alexander Nicolson, B.Sc., Research Engineer, British Broadcasting Corporation, London.

Burke, Maxwell James, M.Sc., Lecturer, University of Queensland.

*Champion, John Valentine, B.Sc., Ph.D., Lecturer, Sir John Cass College, London.

*Clayton, John Andrew, B.Sc., Research Physicist, Dunlop Research Centre, Fort Dunlop, Birmingham.

*Cooke, Geoffrey Peter, B.Sc., Research Physicist, The Metal Box Co. Ltd., London.

Crawford, Frederick William, M.Sc., Ph.D., Senior Lecturer, Electrical Engineering Department, College of Advanced Technology, Birmingham.

Crossley, Frank Brian, B.Sc., Senior Health Physics Officer, Imperial Chemical Industries Ltd., Metals Division, Birmingham.

*Crossley, George, B.Sc., Senior Scientific Officer, Royal Radar Establishment, Malvern, Worcs.

*Daglish, Hugh Neville, B.Sc., Ph.D., Senior Scientific Officer, Post Office Research Station, Dollis Hill, London.

*De Groot, Raymond Joseph, B.Sc., Geophysicist, Bureau of Mineral Resources, Melbourne, Australia.

*Ellis, Robert Frederick, B.Sc., A.R.C.S., Lecturer, Braintree College of Further Education, Essex.

*Emerson, Peter James, B.Sc., Ph.D., Physicist, Round Oak Steel Works, Brierley Hill, Staffordshire.

*Garrett, Eric Lionel, M.Sc., Assistant Valve Engineer, Standard Telephones and Cables Ltd., Paignton, Devon.

Gerrard, Charles Norman, B.Sc., Senior Scientific Officer, Weapons Research Establishment, Salisbury, Australia.

Goodwin, Geoffrey Leonard, B.A., B.Sc., Lecturer, University of Queensland.

Haas, Frederick Alfred, B.Sc., Ph.D., Physicist, The English Electric Co. Ltd., Stafford.

*Hadley, Dennis William, B.Sc., Ph.D., Research Fellow, University of Liverpool.

*Hall, Eric Walter, B.Sc., Ph.D., Senior Technician, Armstrong Siddeley Motors Ltd., Coventry.

*Harris, Keith Dillon, B.Sc., Assistant Engineer, The English Electric Valve Co. Ltd., Chelmsford, Essex.

Harrowell, Raymond Vivian, B.Sc., Senior Experimental Officer, The General Electric Co. Ltd., Wembley, Middlesex.

Heath, Alfred Russell, B.Sc., Lecturer, Brighton Technical College, Sussex.

*Higson, Gordon Robert, B.Sc., Test Engineer, Fairey Aviation Co. Ltd., Hayes, Middlesex.

Hitchcock, John Alan, B.Sc., A.R.C.S., Scientist, National Coal Board, Mining Research Establishment, Isleworth, Middlesex.

Howarth, Harry Menhenitt, B.Sc., Lecturer, College of Technology, Portsmouth, Hants.

Hulley, Bernard James, B.Sc., Development Engineer, Sunvic Controls Ltd., Harlow, Essex.

James, Charles Geoffrey, M.A., Ph.D., Lecturer, Department of Mechanical Engineering, Imperial College of Science and Technology, London.

*Knight, Geoffrey, B.Sc., Scientist, National Coal Board, Mining Research Establishment, Isleworth, Middlesex.

Lamming, Jack Stewart, M.Sc., Senior Scientific Staff, The General Electric Co. Ltd., Wembley, Middlesex.

Lattimore, Samuel, B.Sc., A.R.C.S., Physicist, Kodak (Australia) Pty Ltd.

*Lewis, Cyril Beesley, B.Sc., Lecturer, Medway College of Technology, Chatham, Kent.

Looms, John Sidney Thomas, B.Sc., Assistant Engineer, Central Electricity Research Laboratories, Leatherhead, Surrey.

Michael, William Stanford, B.Sc., Lecturer, College of Technology and Commerce, Leicester.

Millard, Donald Joseph, B.Sc., Ph.D., Reactor Physicist, Central Electricity Generating Board, London.

Mugglestone, Donald, B.Sc., Ph.D., Senior Lecturer, University of Queensland.

Nelson, Hugh Mitchell, B.Sc., Officer-in-Charge, Aeronautical Research Laboratories, Victoria, Australia.

Parrott, John Edwin, B.Sc., Ph.D., Research Physicist, Associated Electrical Industries Ltd., Aldermaston, Berks.

*Peirce, Terence James, B.Sc., Ph.D., Physicist, Central Electricity Research Laboratories, Leatherhead, Surrey.

Powell, Leonard Sutherland, B.Sc., Principal Lecturer, Garnett College, London.

*Preston, Ian Mathieson Hamilton, B.Sc., Assistant Lecturer, University of Glasgow.

Ramanathan, Nochur Lakshminarayana, M.Sc., Assistant Research Officer, Industrial Health Research Unit, Calcutta, India.

*Reichenbaum, George, M.Sc., Ph.D., Head of Development Department, The English Electric Valve Co. Ltd., Chelmsford, Essex.

Rose, Frank Wenzel Georg, Dr.rer.nat., Physicist, British Thomson Houston Co. Ltd., Rugby.

Scott, Victor Denis, B.Sc., Ph.D., Scientific Officer, Atomic Weapons Research Establishment, Aldermaston, Berks.

Sharpe, Bernard William, B.Sc., Physicist, United Kingdom Atomic Energy Authority, Springfield Works, Preston, Lancashire.

*Sheriff, Norman, M.Sc., Scientific Officer, United Kingdom Atomic Energy Authority, Capenhurst, Chester.

Smith, Gordon Victor, B.Sc., Chief Research Engineer, Sparcatron Ltd., London.

*Smith, Terence George, B.Sc., Technician, Kodak Ltd., Harrow, Middlesex.

Soden, Lester Baker, M.Sc., Senior Scientific Officer, Weapons Research Establishment, Salisbury, Australia.

Somekh, Ezra Moshi, M.Sc., Head of Physics Department, Burton Grammar School, Staffordshire.

Spicer, Brian Milton, M.Sc., Ph.D., Senior Lecturer, University of Melbourne.

*Spiers, Veronica Mary, B.Sc., Physicist, Aeon Laboratories, Egham, Surrey.

Stanley, Peter, M.A., Senior Research Assistant, Mechanical Engineering Department, University of Nottingham.

Struys, Theodor Johannes, B.Sc., Scientific Officer, Aeronautical Research Laboratories, Victoria, Australia.

*Wesley, John Dean, B.Sc., Assistant Lecturer, Leicester College of Technology.

*Windle, William, B.Sc., Senior Physicist, English Clays Lovering Pochin & Co. Ltd., St. Austell, Cornwall.

Young, John Eric Ritchie, B.Sc., Ph.D., Physicist, International Business Machines, London.

GRADUATESHIP (59)

Allen, John Edmund, B.Sc., Research Student, University of Durham.

Allenby, Reginald Thornton, B.Sc., Senior Science Master, Salford Technical High School, Salford, Lancashire.

Barnard, Ronald Derrick, B.Sc., Research Student, University of Nottingham.

*Bedford, Alan Frederick, B.A., Research Student, University College of North Staffordshire.

*Bland, Andrew, B.Sc., Experimental Staff, General Electric Co. Ltd., Salisbury, Australia.

Burden, Clive Albert, B.Sc., Scientist, British Oxygen Research and Development Ltd., Morden, Surrey.

Butler, Francis Grenfell, B.Sc., Assistant Master, Maltby Grammar School, Yorkshire.

Campbell, Hugh Findlay, B.Sc., Assistant Teacher, Crookston Castle Secondary School, Glasgow.

*Carter, Ann Cawdron, B.Sc., Physics and Mathematics Mistress, The Willows County Secondary School for Girls, Morden, Surrey.

Champeney, Robert Clive, B.Sc., Head of Physics Department, Hackney Downs School, London.

*Clark, David Beatson, B.A., Physicist, Beatson Clark and Co. Ltd., Rotherham, Yorks.

Coogan, Francis Joseph, B.Sc., Assistant Experimental Officer, United Kingdom Atomic Energy Authority, Capenhurst, Chester.

*Cooper, Janet Olive, B.Sc., Physicist, Smiths Aircraft Instruments Ltd., Nr. Cheltenham, Glos.

*Crawford, Barry, B.Sc., Engineer, De Havilland Propellers Ltd., Hatfield, Herts.

Dalziel, John Antony, B.Sc., Scientist, National Coal Board, Mining Research Establishment, Isleworth, Middlesex.

*Egleton, John Edward, B.Sc., Scientific Officer, The General Electric Co. Ltd., Stanmore, Middlesex.

Evans, Francis Daniel Owen, B.Sc., Assistant Lecturer, Technical College of Monmouthshire, Crumlin.

Eyre, Denis Michael, B.Sc., Research Physicist, Ferranti Ltd., Wythenshawe, Manchester.

Fisher, Sidney Alfred, B.Sc., Scientific Officer, United Kingdom Atomic Energy Authority, Seascale, Cumberland.

Fleet, Stephen George, B.A., Research Student, Cavendish Laboratory, Cambridge.

Flinn, Michael, B.Sc., Lecturer, Institute of Laryngology and Otology, University of London.

*Gill, Christopher John, B.Sc., Physicist, John Thompson Nuclear Energy Co. Ltd., Knutsford, Cheshire.

Glazier, Julien, B.Sc., Assistant Experimental Officer, Atomic Weapons Research Establishment, Foulness, Essex.

Goaman, Llawewydd Constance Gwynne, B.Sc., Research Assistant, University College of South Wales and Monmouthshire, Cardiff.

Goodie, Bernard John Sydney, B.Sc., Senior Scientific Staff, Kodak Ltd., Wealdstone, Middlesex.

Green, John Freer, B.A., Scientist, British Scientific Instrument Research Association, Chislehurst, Kent.

Grieves, Brian Oswald Chilton, B.Sc., Assistant Lecturer, South Shields Marine and Technical College, Durham.

Hanson, Geoffrey, B.Sc., Design Engineer, Ferranti Ltd., Wythenshawe, Manchester.

Hempstead, Colin Antony, B.Sc., Physicist, De Havilland Propellers Ltd., Hatfield, Herts.

Hill, Robert, A.R.C.S., Assistant Experimental Officer, United Kingdom Atomic Energy Authority, Windscale, Cumberland.

Hilyard, Nicholas Clive, B.Sc., Postgraduate Student, University of Southampton.

Howarth, Alan, B.Sc., Geophysicist, Soil Mechanics Ltd., London.

Johnston, Barrie Keith, B.Sc., Assistant Research Officer, Joseph Lucas (Electrical) Ltd., Marston Green, Warwickshire.

Johnston, David Edgar, B.Sc., Assistant Physicist, Boulton Paul Aircraft Ltd., Wolverhampton, Staffordshire.

*Jones, Hugh Thomas Owen, B.Sc., Assistant Master, Coleshill Grammar School, Nr. Birmingham.

*Knight, Alan, B.Sc., Research Student, University of Birmingham.

*Lockie, Ivor Bolton, B.Sc., Research Student, King's College, University of Durham.

McQuarrie, Jessie Elizabeth, B.Sc., Physicist, Clatterbridge Hospital West, Wirral, Cheshire.

*Maclean, Allan, B.Sc., Assistant Experimental Officer, United Kingdom Atomic Energy Authority, Capenhurst, Chester.

Mansfield, John Neville, B.Sc., Scientific Officer, Mechanical Engineering Research Laboratory, Glasgow.

Mills, Donald, B.Sc., Research Student, University College of Wales, Aberystwyth.

*Morgan, John, A.R.C.S.T., Assistant Lecturer, Royal College of Science and Technology, Glasgow.

*Orr, Robert, A.R.C.S.T., Applied Physicist, British Thomson-Houston Co. Ltd., Rugby.

Owen, Michael Wesley, B.Sc., Junior Engineer, De Havilland Propellers Ltd., Hatfield, Herts.

Petchey, David William, B.Sc., Physicist, The Metal Box Co. Ltd., London.

Phillips, David, B.Sc., Research Student, University College of Wales, Aberystwyth.

*Pickard, Roger Martin, B.Sc., Research Student, University of Manchester.

Preece, Kenneth Noel, B.Sc., Research Physicist, The Morgan Crucible Co. Ltd., London.

Ross, Alan, B.Sc., Senior Development Engineer, Marconi's Wireless Telegraph Co. Ltd., Chelmsford, Essex.

Sellen, David Bruce, B.Sc., Research Student, University of Southampton.

*Shieff, Harvey Eric Joseph, B.Sc., Scientific Officer, Atomic Weapons Research Establishment, Aldermaston, Berks.

*Shipley, Anthony David Cureton, B.Sc., A.R.C.S., Postgraduate Student, Imperial College of Science and Technology, London.

Thompson, Denis Harry, B.Sc., Senior Physicist, Microcell Electronics, Camberley, Surrey.

Weatherill, Michael, B.A., Instructor Officer, H.M.S. *Collingwood*, Fareham, Hants.

Wedgwood, Christopher Garry, B.Sc., Research Physicist, Standard Telephones and Cables Ltd., Harlow, Essex.

*West, Richard Scot, B.Sc., Junior Technical Officer, Sir W. G. Armstrong Whitworth Aircraft Ltd., Coventry, Warwicks.

*White, David, B.Sc., Research Technologist, Siemens Edison Swan Research Laboratory, Berks.

*Wilson, David John, B.Sc., Experimental Officer, United Kingdom Atomic Energy Authority, Winfrith, Dorset.

Whitehead, Alan James, B.Sc., Junior Scientist, Plessey Co. Ltd., Towcester, Northants.

One hundred and fifteen Students and eight Subscribers were also admitted.

Report of the Board of The Institute of Physics for the year 1958

TO BE PRESENTED FOR ADOPTION AT THE ANNUAL GENERAL MEETING OF THE INSTITUTE ON 7 JULY, 1959

The Board and its Committees

The present Board took office on October 1, 1958; its members on 31 December, 1958, were:

President: Sir George Thomson.

Immediate Past Presidents: Mr. O. W. Humphreys, Sir John Cockcroft.

Vice-Presidents: Dr. B. P. Dudding, Professor E. A. Owen, Professor E. C. Stoner, Dr. R. W. Sillars.

Honorary Treasurer: Dr. J. Taylor.

Honorary Secretary: Professor F. A. Vick.

Ordinary Members of the Board: Dr. M. R. Hopkins, Dr. J. M. A. Lenihan, Dr. A. C. Menzies, Mr. F. Oldham, Dr. J. Thewlis, Dr. J. Topping, Dr. L. R. G. Treloar, Mr. G. W. Warren.

Chairmen of Branches in Great Britain; Mr. F. I. Hurley (Liverpool and North Wales), Professor A. M. Taylor (London and Home Counties), Professor H. Lipson (Manchester and District), Dr. R. E. Bastick (Midland), Dr. O. P. T. Kantorowicz (North-Eastern), Mr. R. M. Sillitto (Scottish), Dr. M. R. Hopkins (South Wales), Professor S. H. Piper (South-Western), Professor W. Sucksmith (Yorkshire).

Representing The Physical Society: Dr. H. H. Hopkins, Dr. D. A. Wright.

During the year the Board met five times and appointed the undermentioned Standing and Executive Committees which held eighteen meetings.

Finance and General Purposes Committee (*Chairman:* The Treasurer).

Membership and Education Committee (*Chairman:* Mr. G. W. Warren).

Benevolent Fund Committee (*Chairman:* Dr. J. Taylor).

Journals Advisory Committee (*Chairman:* Dr. J. M. A. Lenihan).

Meetings Committee (*Chairman:* Dr. R. W. Sillars).

Non-periodical Publications Committee (*Chairman:* Professor F. A. Vick).

Careers in Physics Committee (*Chairman:* Dr. J. M. A. Lenihan).

Physics of Nuclear Power Committee (*Chairman:* The President).

Representatives and nominees on joint committees and other bodies

The Institute has been represented as follows and summaries of the principal work of those bodies likely to be of interest to members are given in the appendix to this Report.

On The Royal Society's National Committee for Physics: Professor F. A. Vick.

On The Royal Society's National Committee for Crystallography: Dr. W. H. Taylor.

On The Royal Society's Paul Instrument Fund Committee: Sir Frank Smith.

On the Board of The British Nuclear Energy Conference: The President, Dr. J. V. Dunworth and Dr. H. R. Lang.

On the Parliamentary and Scientific Committee: Professor F. A. Vick and Dr. H. R. Lang on the General Committee, together with Mr. O. W. Humphreys and Dr. J. Taylor at the Annual Meeting.

On the Committee of Management of Science Abstracts: Dr. L. R. G. Treloar.

On the National Council for Technological Awards' Board of Studies in Technologies other than Engineering: Dr. N. F. Astbury.

On the City and Guilds of London Institute's Advisory Committee on Courses for Laboratory Technicians: Mr. N. Clarke, Mr. T. H. Tyler and Mr. L. Walden.

On the City and Guilds of London Institute's Advisory Committee on the Training of Instrument Mechanics and Technicians: Mr. N. Clarke.

On the City and Guilds of London Institute's Advisory Committee on Industrial Radiography: Mr. N. Clarke, Mr. F. Y. Poynton and Mr. W. E. Schall.

On the Joint Committee with the Ministry of Education for National Certificates in Applied Physics: Mr. A. E. De Barr, Mr. F. I. Hurley, Dr. J. Topping and Mr. G. W. Warren.

On the Joint Committee with the Scottish Education Department for National Certificates in Applied Physics: Mr. J. R. Atkinson, Dr. J. M. A. Lenihan and Dr. G. Morris.

On the British Committee for Radiological Units: Mr. W. Binks.

On the Joint Committee (with The American Society for Testing Materials and The American Crystallographic Association) for Chemical Analysis by X-ray Diffraction Methods: Professor A. J. C. Wilson.

On the Ministry of Labour and National Service's Panel on Special Regulations for Protection against Ionizing Radiations: Mr. H. P. Rooksby, Mr. W. E. Schall.

On the British Group for Computation and Automatic Control of the British Conference on Automation and Computation: Dr. A. D. Booth and Mr. N. Clarke.

On the British National Committee for Non-Destructive Testing: Dr. J. Thewlis.

On the Organizing Committee of the International Congress of Crystallography: Professor E. G. Cox.

On The Physical Society's Exhibition Committee: Mr. N. L. Harris.

On the Panel for Consideration of School Examination Syllabuses in Physics of the Science Masters' Association: Dr. H. H. Hopkins.

On the Court of the University of Exeter: Professor S. H. Piper.

On the Court of the University of Hull: Dr. E. C. Craven.

On the Court of Governors of Manchester College of Science and Technology : Dr. R. W. Sillars.

On the Governing Body of Brunel College of Technology : Mr. E. R. Davies.

On the Governing Body of Croydon Technical College : Mr. C. L. S. Gilford,

On the Governing Body of Kingston Technical College : Dr. G. D. Robinson.

On the Governing Body of Norwood Technical College : Dr. W. Betteridge.

On the Governing Body of Rutherford College of Technology: Mr. G. N. Peel.

On the Governing Body of South East London Technical College : Dr. J. Thomson.

On the Governing Body of the Welsh College of Advanced Technology, Cardiff : Dr. H. O. Puls.

On the Advisory Committee for Applied Physics of the London and Home Counties Regional Advisory Council for Higher Technological Education : Mr. N. Clarke, Mr. F. Y. Poynton and Mr. G. W. Warren.

On the Technical Education Sub-Committee of Monmouthshire Education Committee : Dr. P. Hatfield.

On the Joint Science Advisory Sub-Committee of the Regional Council for Further Education in the South West : Professor S. H. Piper.

On the Advisory Sub-Committee for Electrical Engineering and Applied Physics of the Welsh College of Advanced Technology, Cardiff: Mr. R. G. Wood.

On the Sub-Committee on Specialist Courses in Electrical Engineering of the Welsh Academic Board of Technology : Mr. W. S. Vernon.

On the Advisory Committee for Electrical Engineering of Rutherford College of Technology : Mr. G. N. Peel and Dr. E. E. Schneider.

On the Consultative Committee for Electrical Engineering and Applied Physics of the South East London Technical College : Mr. N. Clarke.

On the Advisory Committee on Physics of Battersea College of Technology : Dr. W. F. Berg.

On the Applied Science Advisory Committee of Birmingham College of Technology : Mr. M. Milbourn.

On the Science Advisory Committee of Blackburn Municipal Technical College : Dr. A. Hargreaves.

On the Science Advisory Committee of Bournemouth Municipal College of Technology and Commerce : Mr. A. F. Blaylock.

On the Science Advisory Committee of Bury Municipal Technical College :

On the Science Advisory Committee of Croydon Technical College : Mr. S. Hill.

On the Science Sub-Committee of the Eastern Area Technological Committee of the East Anglian Regional Advisory Council for Further Education : Mr. H. A. Nancarrow.

On the Science Advisory Committee of Ewell County Technical College : Dr. J. S. Forrest.

On the Council for Science of Ipswich Civic College : Mr. H. A. Nancarrow.

On the Advisory Committee for Applied Physics of Kingston Technical College : Dr. G. D. Robinson.

On the Science Advisory Committee of Luton and South Bedfordshire College of Further Education: Dr. R. W. Williams.

On the Science Advisory Committee of Merseyside District Advisory Council for Further Education: Professor J. D. Craggs.

On the Science Advisory Committee of Northampton College of Advanced Technology : Dr. J. T. Kendall.

On the Science Advisory Committee of Poole College for Further Education : Mr. C. F. Oxbrow.

On the Applied Science Advisory Committee of the Royal Technical College, Salford : Mr. D. A. Crooks.

On the Science Advisory Committee of Salisbury and South Wilts College of Further Education : Mr. H. L. Green.

On the Science Advisory Committee of Slough College of Further Education : Mr. J. Yarwood.

On the Science Advisory Committee of Southend-on-Sea Municipal College : Mr. N. Clarke.

On the Advisory Committee for Physics of West Ham College of Technology : Mr. L. V. Chilton.

On the Applied Science Advisory Committee of the Wolverhampton and Staffordshire College of Technology : Dr. D. E. C. Corbridge.

On the Yorkshire Council for Further Education Advisory Panel for Physics : Mr. S. L. Anderson, Dr. K. W. Andrews, Mr. D. F. Burnett, Dr. E. C. Craven, Dr. M. McCaig, Mr. B. O. Payne.

On British Standards Institution Committees : The Institute has been represented on twenty-two Committees of the B.S.I.

General Meetings

The 38th Annual General Meeting of the Institute was held on July 1, and an Extraordinary General Meeting on September 10, both in the Institute's House. The latter adopted the Board's proposals regarding increase of members' fees.

Election of Honorary Fellow

At the Annual General Meeting on July 1, Sir (William) Lawrence Bragg was declared elected an Honorary Fellow.

Membership

During the year 851 applications for election or transfer to the various grades were received for submission to the Membership and Education Committee, compared with 795 applications in 1957. The numbers for the grades (with the 1957 numbers in brackets) were: Fellows 74 (68), Associates 227 (246), Graduates 224 (254), Students 308 (212), Subscribers 18 (15). The Interview Panel met four times and interviewed twenty-one candidates.

Representatives of the Committee visited seven technical colleges which had applied for recognition by the Institute as institutions having courses of study approved for the purpose of the membership regulations. Six of the applications were accepted.

The continued growth of the Institute is shown in the following table.

Table 1. *Growth of the Institute over the last ten years*

1949	... 3657	1954	... 4749
1950	... 3858	1955	... 5146
1951	... 4080	1956	... 5531
1952	... 4347	1957	... 5881
1953	... 4595	1958	... 6309

The changes that have occurred during the year are displayed in Table 2.

Table 2. *Changes in the Register in 1958*

	Total on Dec. 31, 1957	*Elections*							*Net Increase or Decrease*	*Total on Dec. 31, 1958*
		New	*Transfers to*	*Re-admitted*	*Resigned*	*Deceased*	*Removed*	*Transfers from*		
Hon. Fellows ...	7	—	1	—	—	—	—	—	+ 1	8
Fellows	1087	14	47	2	3	14	1	1	+ 44	1131
Associates	2371	106	94	—	12	6	5	47	+130	2501
Graduates	1303	163	45	2	14	2	7	94	+ 93	1396
Subscribers	453	16	2	1	36	2	4	—	− 23	430
Students	673	305	—	—	33	—	55	47	+170	843
TOTAL	5894	604	189	5	98	24	72	189	+415	6309

Deaths. The Board records with regret the deaths in 1958 of:

> *Fellows:* F. Ashworth, B. N. Clack, R. M. Davies, P. M. Gilet, D. R. Hartree, H. G. Hughes, H. S. Kipling, K. Konstantinowsky, S. R. Milner, G. F. New, J. M. Nuttall, J. K. Robertson, A. S. M. Symons, D. J. Thomas. *Associates:* K. H. Barker, E. G. Godfrey, W. E. Dickes-Rost, F. Tattersall, N. B. Terry, W. J. Todd. *Graduates:* J. M. Chisholm, J. D. Padbury. *Subscribers:* R. E. Franklin, J. J. Sayer.

Examinations

Graduateship Examination. The Graduateship examination was held on June 2-6. Written papers were taken at The Polytechnic, Regent Street, London; the College of Technology, Birmingham; Paisley Technical College; the Royal Technical College, Salford; and the Technical College, Swansea. The practical examination was held at The Polytechnic, Regent Street. The examination papers and the comments of the examiners were published in the September *Bulletin*, and subsequently as a pamphlet.

Eighty candidates took the examination (compared with 68 in 1957, and 45 in 1956) and 26 passed. Of the successful candidates, 12 were university graduates and 14 held the Higher National Certificate in Applied Physics.

Fifteen question papers were set, and the examiners were Professor J. G. Wilson, Professor H. Lipson, Mr. A. E. De Barr, Mr. R. F. Farr, Dr. C. A. Taylor, Dr. A. W. Gillies, Mr. E. D. Van Rest, Mr. N. Clarke, and Mr. J. Yarwood. Professor Wilson has now retired as an examiner, and Professor J. D. Craggs has been appointed in his place.

National Certificates in Applied Physics. Forty-one colleges presented 637 candidates for the examinations for the Ordinary National Certificate in Applied Physics (compared with 542 in 1957, and 424 in 1956). The entry for the Higher National Certificate examinations was 246 candidates from 20 colleges (compared with 182 candidates in 1957, and 152 in 1956). The number of colleges offering courses for these certificates continues to increase very satisfactorily. For the 1958 examinations the Institute's assessors were Professor J. D. Craggs, Dr. J. Crank and Mr. A. E. De Barr for England and Wales, and Dr. G. Morris for Scotland. Dr. Morris has now retired after serving for seven years, and Dr. J. M. Valentine has been appointed to succeed him.

Full details of the 1958 examinations, including the results at individual colleges, were published in the November *Bulletin*.

Education

Postgraduate Training of Physicists. A joint committee of the Institute and the Physical Society was set up to enquire into the postgraduate training of physicists, including the relevance of this to the needs of fundamental and applied research. The Institute's representatives were Dr. J. N. Aldington, Dr. R. Beeching, Professor R. V. Jones, Mr. L. Rotherham and Professor J. G. Wilson, with the Deputy Secretary as the Secretary of the Committee. Later in the year Dr. Aldington had to retire because of pressure of other work, and has been replaced by Dr. R. W. Sillars.

The Committee's procedure will include discussions with university and industrial physicists, and with this in mind the Committee is holding its meetings in different parts of the country.

The Teaching of Mathematics to Physicists. The Report on *The Teaching of Mathematics to Physicists* was prepared by a joint committee of the Institute and the Mathematical Association, and was originally published in 1943. It has since been reprinted several times, but has not been revised. The Membership and Education Committee has now appointed a Panel, consisting of Dr. A. W. Gillies, Dr. M. R. Hopkins, Professor L. Howarth, Dr. H. Lowery, Dr. J. Topping and Mr. N. Clarke, to make such revisions and extensions of the Report as may now seem desirable, and it is hoped that a completely new edition of the Report will be available shortly.

Grants to Students. The Government has appointed a committee under the chairmanship of Sir Colin Anderson to enquire into the awards made to students in first-degree courses in universities and comparable courses in other institutions, and the committee invited interested bodies to submit evidence and memoranda for its consideration. The Membership and Education Committee, on behalf of the Board, prepared and submitted a memorandum which was subsequently published in the January, 1959, *Bulletin*, and copies of which have been circulated to sister institutions and various educational bodies.

Recognition of Diplomas in Technology. Two further requests were received from colleges of technology for the recognition by the Institute of courses on which it was expected that the Diploma in Technology would be awarded. Representatives of the Membership and

Education Committee visited the colleges and reported to the Committee and the Board. One application (Borough Polytechnic, London) was approved and the other rejected.

The Institute now recognizes eight courses on which the Diploma in Technology in physics is awarded and these Diplomas carry complete exemption from the Graduateship examination. In addition, one college Diploma is recognized.

Publications

The Journals. The circulation of the *Journal of Scientific Instruments* again increased by about 10 per cent, but there was no significant change in the circulation of the *British Journal of Applied Physics* to either members or non-members.

The advertisement revenue from the journals showed a further decline and the Board therefore decided to make new arrangements for selling advertising space, which will become effective with the April, 1959, issues.

Table 3 shows the amount of material submitted and published during the year, compared with the previous year. Of the 183 papers submitted to the *Journal of Scientific Instruments* during the year and the 143 papers to the *British Journal of Applied Physics*, 22 and 37 respectively were still under consideration at the end of the year.

The Advisory Committees of both journals were satisfied that, thanks to the vigilance of referees, the scientific standard of the papers had been well maintained. It was decided, however, to endeavour to widen the content and scope of the *British Journal of Applied Physics*. The June and October issues of this journal carried New Books sections which together contained reviews of 87 new books ; this feature is to be continued in future issues. The indexes of both journals were in a new style, in which the papers were grouped in subjects ; it is believed that this arrangement will make them of greater use to readers. Both Journal Committees considered that the standard of preparation of scripts had declined in recent years, and attention is to be called to the Institute's *Notes on the preparation of contributions*, in an endeavour to improve the situation.

During the year the present refereeing system was reviewed but it was decided to make no changes.

The Board decided to combine the two large Journal Committees (one for each journal) and to appoint a small Steering Committee for each journal to advise the Editor on day-to-day matters and to guide the main Committee. The two Steering Committees held their first meeting jointly on December 3.

Bulletin. The type size of the *Bulletin* was reduced for the 1958 volume and a considerable saving of paper thereby achieved. The twelve monthly issues consisted of 336 text pages and contained slightly more material than the 404 pages of the previous volume. Twenty-five articles were published together with the usual lists of elections, notices, accounts of Branch and Group activities and summaries of the contents of the Institute's two scientific journals. Reviews of fifty-two books were also published. A total of 357 advertisements of vacancies for physicists (many of them relating to multiple vacancies) was included, compared with 382 in 1957. In July a separate 12-page advertisement supplement was issued, dealing with courses in colleges of technology.

Books. During the year the Board set up a Non-Periodical Publications Committee to select titles and authors and to approve manuscripts for the books to be published by Chapman & Hall Ltd. on behalf of the Institute under the agreement reported last year.

New titles in both the Physics in Industry and the Student Monograph series have been chosen and authors have agreed to prepare manuscripts.

The Proceedings of the London and Home Counties Branch Symposium on *The Design of Physics Research Laboratories*, held in November, 1957, was the first volume of Conference Proceedings to be ready for publication under the new arrangement. (It appeared in January, 1959.) A second edition of *Physics as a Career* by the Deputy Secretary was at press at the end of the year and further impressions of two of the titles in the Monographs for Students series were issued during the year.

Table 3. *Contributions submitted and published*

	J.S.I.		*B.J.A.P.*	
	1957	*1958*	*1957*	*1958*
Extent of Journal (text pages)	*520*	480	*502*	500
Original papers (numbers) *:*				
Submitted	*159*	183	*121*	143
Accepted	*104*	124	*85*	93
Published	*97*	110	*83*	89
Special articles and conference reports published (numbers)	*11*	3	*13*	11
Laboratory and Workshop Notes (numbers) *:*				
Submitted	*97*	102	—	—
Accepted	*62*	72	—	—
Published	*65*	75	—	—
New Instruments, Materials and Tools :				
Items published	*70*	88	—	—
Notices of manufacturers' publications	*89*	67	—	—
Letters to the Editor published	*18*	18	*17*	11
Number of book reviews published	*32*	26	*133*	121
Extent of Supplement (text pages)	—	—	*69*	—

Annual Dinner

Although the Institute has held dinners in connexion with its conferences and other functions, it was not until March 26, 1958, that its first Annual Dinner was held. It took place at the Savoy Hotel, London, and there were 267 members and guests present. The President was in the Chair, and replied to the toast of "The Institute of Physics" proposed by Viscount Hailsham ; the reply to "The Guests," proposed by Sir John Cockcroft, was made by Sir George Barnes.

Organization and co-ordination of Meetings

The Meetings Committee, which was set up last year, has the following terms of reference :—

(1) To organize meetings on a national basis, mainly in London.
(2) To promote meetings of specialist interest, which might or might not lead to the formation of Groups, depending upon the continued response.
(3) To consider the activities of the Groups in relation to the general work of the Institute and to make recommendations to the Board.

During the year the Committee advised the Board on a number of proposals for conferences and symposia that had been made by members, and presented an interim report on its deliberations about the work of the Groups.

Professional matters

Enquiries. The Permanent Officers, often advised by the Honorary Officers or other Fellows of the Institute with special knowledge, have as usual dealt with a number of confidential enquiries concerning professional matters. These were similar to those of previous years, including particularly enquiries about terms of contracts of service, suitability of salaries for various posts, availability of courses at all levels and prospects for physicists and home and oversea.

An increasing number of enquiries are now received each year from publishers and various organizations that issue year-books, encyclopædias etc. for help in compiling and checking entries relating to the education or professional activities of physicists.

Availability of places for physics students. A second enquiry was conducted into the number of places for physics students available in universities and recognized technical colleges. Information was supplied by thirty-five university departments and seventy technical colleges. The report of the survey was published in the June *Bulletin* and reprints were widely distributed ; its importance was commented upon by several leading newspapers.

The adoption of the metric system. In response to an enquiry from the British Association on behalf of a Committee enquiring into the suggestion that the metric system be adopted in this country, the Board expressed its view in respect of measurements in the physical sciences.

Proposed amalgamation of the Institute and The Physical Society

On December 12 a circular was sent to members of all grades, proposing the amalgamation of the Institute and The Physical Society. The outline of a plan for this, which had been prepared by the Honorary Officers of the two bodies, was set out in the circular. It was stated that if the broad basis of intention were accepted the Board of the Institute and the Council of the Society would set up a joint committee to work out all the details, with financial and legal advice.

The Institute's House

Owing to the need for economy, only essential repairs and normal maintenance work were carried out ; the work required to bring the mews premises into use, which had been planned for this year, was reluctantly postponed.

The number of Institute meetings held in the House during the year is shown in Table 4.

Table 4. *Meetings held in the House*

	1956	*1957*	*1958*
Board and committee meetings (including Branch and Group committees)	59	75	90
Conferences and lecture meetings...	30	28	29
Social functions	5	14	15

Acknowledgements

Branch, Group and Conference Officers. The Board wishes to record its thanks to those members who have acted as Honorary Officers of the Institute's Branches, Groups and Conferences and who have thereby contributed greatly to the Institute's activities.

Meeting Rooms and Visits. The Board records its thanks to the many bodies which have generously allowed meetings of the Institute and of its Branches and Groups to be held on their premises.

Finance

The accounts are presented in the same way as in recent years with the same proportional allocation between them of the costs of running the House and the offices. The final deficit for the year on the combined accounts (Institute and Endowment Trust Fund) is £1,728.

The Institute of Physics Accounts. The Institute's accounts call for no special comment this year beyond noting the satisfactory further increase of members' subscriptions resulting from increased membership. Following the normal practice, funds have been transferred from this account to the Endowment Trust Fund account, thus providing a contribution from members' subscriptions towards the cost of the educational and scientific work, including the work of the Branches and Groups, carried out in the Institute's name through the Trust Fund. In order to meet the growing deficit of this Fund, it has been necessary to increase this contribution substantially; the amount for the year was £4,050. The resulting deficit on the Institute's account has reduced its reserves by a corresponding amount.

Endowment Trust Fund Accounts. The surplus for the year on the publications business (which forms the major portion of this account) was £898 less than the previous year. This is mainly accounted for by a reduction in advertisement revenue. The total turnover on the publications account was, however, considerably less than in previous years as no books or supplements to the journals were published.

The deficit on the year's working was £1,762 which has been added to the Fund's Debit balance which now stands at £2,563.

During the year, agreement was reached with the Committee of the X-ray Analysis Group upon the terms and conditions on which grants could be made from the *A.S.T.M. X-ray Powder Data File* Fund, which now stands at £22,795 and is one of the liabilities.

Remission of income tax on members' subscriptions. In October, 1958, the Institute was approved by the Commissioners of Inland Revenue "for the purposes of Section 16 of the Finance Act, 1959." This enables the whole of the annual subscription paid by a member who qualifies for relief under that section to be allowable as a deduction from his emoluments assessable to income tax under Schedule E.

Benevolent Fund

Subscriptions and donations from members amounted to £781 compared with £743 the previous year. The Fund Committee is grateful to them for this help and to those who have provided the royalties from the books. It greatly appreciates a donation of £200 from the Australian Branch's Special Fund, which was sent in recognition of the help which has been given to some members' dependants in Australia. The Fund received a further payment of £558 from the Trust set up by the will of the late Mrs. Phillips, including the refund of income tax paid. Towards the end of the year, an appeal was made to members to contribute to the Fund under seven-year covenants to enable it to recover the income tax paid on these donations. Just over 400 members were good enough to sign covenants. This further increase in income will help the Committee to build up its capital reserves to enable it to give adequate help if and when circumstances arise that may unfortunately cause more members or their dependants to call on the Fund for help. The Committee is therefore particularly grateful to those who have now signed covenants, and hopes that more will follow their example. The calls on the Fund during the year were in respect of five old cases and four new ones. A sum of £857 was paid out for assistance.

The Fund Committee wishes again to record its thanks to those members who have investigated cases on its behalf or have acted as trustees of money provided from the Fund.

Branches and Groups

Annual Conference of Branch and Group Officers. The fifteenth Annual Consultative Conference of the Honorary Officers of U.K. Branches and Groups was held in the Institute's House on 30 June. The Honorary Treasurer spoke about the Institute's financial position and the Board's proposals for its improvement. The meeting expressed the view that the majority of members would support these proposals, including the increase in subscriptions.

The President told the Conference about the exploratory discussions that had been proceeding with Physical Society representatives regarding ways and means of amalgamating the Institute and Society. The Conference welcomed the proposals to re-open negotiations upon the basis suggested by the exploratory talks (see also above).

The proposal to discontinue the experiment of allowing interested persons to join a single group only at a reduced fee, in the non-official grade of Group-Subscriber, did not find favour with the Conference. (The Board subsequently postponed its decision on this matter.)

Other items considered were the arrangement for publication of communications made to Branch and Group meetings, recruitment literature, the *Bulletin* and the annual dinner.

The Branch and Group Officers named below were serving at 31 December, 1957 :

Australian Branch : *President :* Professor H. C. Webster. *Vice-President :* Dr. J. L. Pawsey. *Honorary Treasurer :* Dr. J. S. Rogers. *Honorary Secretary :* Dr. J. K. Mackenzie. (481 members.)

The sixth instrument exhibition, which was a great success, was organized by the South Australian Division and held in Adelaide on August 19-22, at the same time as the Adelaide meeting of A.N.Z.A.A.S.

The Divisions of the Branches in the different States have again held many meetings. In addition, the "Solid State Physics" Group is now firmly established in New South Wales and the second Einstein Memorial Lecture was delivered in October in Adelaide by Professor Bart J. Bok on the subject of "Stellar Evolution."

The Victorian Division continues to support the "Science and Technology Careers Bureau" and the Branch is represented as follows :

Australian National Committee on Illumination	Mr. R. Blevin
National Association of Testing Authorities	Dr. N. B. Lewis
Australian Journal of Physics Advisory Committee	Dr. G. H. Briggs
Australian National Committees of U.N.E.S.C.O. for Natural Sciences	Dr. G. H. Briggs
Conjoint Board of the College of Radiologists of Australasia and the Australasian Institute of Radiography ...	Mr. D. J. Stevens
Delegates to the Council of A.N.Z.A.A.S. ...	Professor L. G. H. Huxley Dr. F. W. Wood Dr. J. K. Mackenzie

Malayan Branch. *Chairman :* Mr. Y. S. Hon. *Honorary Secretary-Treasurer :* Dr. Y. K. Lim. (25 members.)

Owing to the small number of members residing in Singapore and the difficulty of recruiting suitable speakers, talks have not been held this year. Instead, arrangement has been made with the Department of Physics of the University of Malaya for members to attend their monthly colloquia ; several have taken advantage of this arrangement.

Liverpool and North Wales Branch. *Chairman :* Mr. F. I. Hurley. *Honorary Secretary :* Dr. A. Ashmore. (220 members.)

During the year seven lectures were held in Liverpool and one in Bangor. The branch draws considerable support from the U.K.A.E.A., at Capenhurst and the attendance at Liverpool meetings depended appreciably on whether the demand was sufficient to justify running a bus from Capenhurst. In December, when members of the constituent bodies of the British Nuclear Energy Conference were invited to Mr. Pease's lecture on " Thermonuclear power," the attendance was about 130.

In November an evening discussion was held on " The Physicist in Industry." A brief report of this meeting appeared in the December *Bulletin.*

Following the Board's suggestion for the encouragement of recruitment to the profession, a local panel was formed of 17 lecturers from industry. Six schools were visited during the autumn term and further visits have been arranged.

London and Home Counties Branch. *Chairman :* Professor A. M. Taylor. *Honorary Secretary :* Mr. D. T. R. Dighton. (2,604 members.)

Six ordinary lecture meetings were held during the year. In addition, the following special functions took place.

In March a joint meeting was held with the London Sections of the Royal Institute of Chemistry and of the Institute of Biology, the subject being " Science and Society." The main papers were presented by Professor L. T. Hogben, Professor A. Haddow, Professor Dame Kathleen Lonsdale and Mr. Anthony Smith. The meeting was well attended and gave rise to a lively discussion.

Two afternoon visits were made during the year. In April a party of members visited London Airport to examine the air-traffic control facilities, the telecommunications equipment and the meteorological offices. Preceding Mr. Lucas' lecture in October, a group of members and visitors viewed the laboratories of Ewell County Technical College.

The Branch Summer Meeting was held in June, when a large party of members and their guests visited Marchwood Power Station near Southampton. In the afternoon the party visited Beaulieu Abbey, Bucklers Hard, and toured the New Forest area.

An " At Home " took place in the Institute's House in October, and was much enjoyed by those members and their ladies who were able to attend, for the demand for tickets was so great that not all who wished could be accommodated.

Manchester and District Branch. *Chairman :* Professor H. Lipson. *Honorary Secretary :* Dr. J. E. Geake. (439 members.)

The Branch held six lecture meetings during the year; these included Professor Blackett on " The antiquity of technology " and Mr. J. Maddox, the Scientific Correspondent of the *Manchester Guardian* on " Scientific journalism" and a joint meeting with the Non-destructive Testing Group.

The Branch Annual Dinner was held in March in the Staff House of the University of Manchester. Dr. Toy and Dr. W. H. Taylor were the principal guests, and dinner was followed by the demonstration of a number of scientific curiosities brought by members.

In June a visit was paid to the Research Laboratories of the British Rayon Research Association at Heald Green. After introductory talks by the Director, Mr. Wiseman, and by Dr. Treloar, there were visits to several laboratories and to the experimental spinning and weaving sheds ; discussion continued over tea.

Midland Branch. *Chairman :* Dr. R. E. Bastick. *Honorary Secretary :* Dr. W. T. Roberts. (601 members.)

Four lectures were held in Birmingham, and visits were made to the Physics Department of the University of Nottingham and I.C.I. (Metals Division) Ltd. at Birmingham, both visits being followed by talks.

A joint one-day symposium with the Electronics Group was held at Malvern in April (reported below).

The Branch annual dinner was again held in the Students Union of the University of Birmingham, and Professor Thomas Bodkin was the guest of honour.

North Eastern Branch. *Chairman:* Dr. O. P. T. Kantorowicz. *Honorary Secretary:* Dr. W. D. Corner. (169 members.)

The Branch held four lecture meetings, two in Newcastle and two in Durham. Two joint lecture meetings were also held, one with the Durham Colleges Physical Society, and one with the Society of Instrument Technology at Middlesborough. In addition, one of the Newcastle lectures was repeated at Seascale for the benefit of members in West Cumberland. These are the first meetings of the Branch to be held in Teeside or in Cumberland.

A whole day meeting on " Pile physics " was held at the Windscale and Calder Hall establishments of the U.K.A.E.A. in September and attended by 44 members and guests. A programme of lectures in the morning was followed by a tour of the Calder Hall reactors in the afternoon. A dinner was held at Seascale in the evening.

Scottish Branch. *Chairman :* Mr. R. M. Sillitto. *Honorary Secretary :* Dr. A. R. Boyle. (297 members.)

Twenty-five lectures were given at the various centres in Scotland as follows : eight in Edinburgh, nine in Glasgow, four in Aberdeen and four in Dundee.

A " Summer meeting " took place over a week-end in June at the Experimental Reactor Establishment at Dounreay ; a report on the lectures and visit was published in the September *Bulletin.*

The Branch lectures for 1958 covered a wide range ; among them were : Professor J. D. Bernal on " The liquid state " and " The structure and development of the planets " ; Mr. A. D. LeClaire, on " Metal physics at Harwell " ; Dr. S. C. Curran, on " Controlled thermonuclear work " and Professor R. V. Jones on " An approach to the limits of infra-red detection."

South Wales Branch. *Chairman:* Dr. M. R. Hopkins. *Honorary Secretary:* Dr. H. O. Puls. (229 members.)

The Branch suffered a grievous loss through the death of its Chairman, Professor R. M. Davies, early in the year. Ordinary meetings of the Branch were held in

Cardiff, Swansea and Aberystwyth. The subjects of the lectures included micro-wave triodes, theory of dissolution shapes of crystals, fluorescent lamps, nuclear magnetic resonance and dislocation in crystals. A rather unusual lecture was given by Dr. Grey Walter on " The cybernetic approach to mentality and society."

The Branch is represented on the Co-ordinating Committee of Scientific Societies in South Wales and Monmouthshire ; at a meeting arranged under its auspices, Sir Hugh Beaver spoke on " A Ministry of Science."

South Western Branch. *Chairman :* Professor S. H. Piper. *Honorary Secretary :* Dr. S. H. Ayliffe. (241 members.)

Four lectures have been held in Bristol, one at Gloucester and one at Cheltenham. In addition, a summer meeting took the form of a visit to the Norman Lockyer Observatory at Sidmouth, followed by a lecture on " Astronomical and atomic time " at the University of Exeter. It was the first visit of the Branch to Exeter, and the members of the South Western Group of the Hospital Physicists Association participated in the meeting.

In April a three day conference on " Physics in schools " was held at the University of Bristol in conjunction with the Education Group. There was an attendance of over one hundred members, mainly from schools, colleges and universities in the south and west of England.

Yorkshire Branch. *Chairman :* Professor W. Sucksmith. *Honorary Secretary :* Dr. M. McCaig. (262 members.)

Two meetings of the Branch were held in Leeds and two in Sheffield. The Summer Meeting took the form of a visit to the University of Hull and Beverley Minster. Two of the lectures, one by Dr. R. L. F. Boyd on " Research by rockets and satellites " and the other by Mr. R. S. Pease on " Thermonuclear power " attracted record audiences.

Applied Spectroscopy Group. *Chairman :* Dr. A. C. G. Menzies. *Honorary Secretary :* Mr. F. W. J. Garton. (233 members.)

The program of the Group has consisted of a number of afternoon scientific meetings. The first held on February 21, in collaboration with the X-ray Analysis Group was a colloquium on " X-ray fluorescence spectroscopy." This meeting was so well supported that a repeat meeting was held on April 1 ; a report of the meeting will appear shortly in the *British Journal of Applied Physics*.

On November 14, following the Group Annual General Meeting, a paper on " The spectroscopy of discharge plasma " was read by Dr. W. R. S. Garton. This was followed by a review, contributed by various members of the Liège International Colloquium on Applied Spectroscopy (1958).

A special meeting of the Group was held on December 3 to welcome Professor S. L. Mandelstam of the Moscow Academy of Sciences, who spoke on recent investigations in the spectroscopic analysis of metals.

The Board granted the Group authority to participate in the work of the Committee of British Spectroscopists.

The Working Party formed by the Committees of the Applied Spectrocopy and Education Groups has met several times and has formulated proposals for a 4-week summer course in applied spectroscopy.

Education Group. *Chairman :* Mr. G. W. Warren. *Honorary Secretary :* Mr. T. H. Tyler. (373 members.)

Six lecture meetings were held in the Institute's House. The annual Easter conference was held at the University of Bristol, jointly with the South-Western Branch, the subject being " Physics in schools."

The Summer Meeting consisted of a visit to Dulwich College, when the School, the Science Department, Art Gallery and a school boarding house were shown to a number of members and their guests.

The joint Working Party of the Group and the Applied Spectroscopy Group is referred to above.

Electronics Group. *Chairman :* Dr. M. E. Haine. *Honorary Secretary :* Dr. C. A. Hogarth. (581 members.)

During the year the Group continued its work which was largely of an educational nature. Its lectures on topical subjects in the realm of physical electronics or electronic physics were delivered by invited authorities.

During April the Group collaborated with the Midland Branch in a one-day symposium in Malvern on " Some applications of solid state physics in computers and automation " at which five papers were read. After this meeting some members were able to visit the Physics Department of the Royal Radar Establishment, in Malvern.

In September the Group held a two-day conference on " Solid state memory and switching devices " at University College, London, when five papers were delivered by authorities in the field and the discussion time was fully occupied. About 200 people attended this conference.

Electron Microscopy Group. *Chairman :* Dr. J. W. Menter. *Honorary Secretary :* Mr. A. W. Agar. (314 members.)

The Group held a joint meeting with the Royal Photographic Society on May 30 in Cambridge, which was attended by over one hundred members from the two bodies. Of particular interest were papers reviewing the characteristics of photographic plates on exposure to electrons. Over 40 members of the Group attended the International Conference on Electron Microscopy, held in Berlin, in September. A one day symposium on " Electron staining " was held on November 27 in London. The following day a joint meeting with the X-ray Analysis Group was held on the subject of " Precipitation in alloys " (see below).

Three Newsletters were circulated during the year.

Non-Destructive Testing Group. *Chairman :* Mr. B. R. Byrne. *Honorary Secretary :* Mr. R. S. Sharpe. (389 members.)

In an attempt to link up with those on the continent working in similar fields, the Group held its summer meeting in Paris jointly with the Société Française de

Métallurgie. The theme of the program was "The utilization of physical properties for studying relationships between the constitution structure and service behaviour of metals." There were 40 British members at the conference.

The first Group dinner-meeting was arranged for members and their ladies in January when Professor Allsopp gave an after-dinner talk on crime investigation. In October a debate was arranged to give members an opportunity to discuss the Group's policy and program. As the start of an attempt to extend the Group's activities into the provinces, a meeting was arranged in Manchester jointly with the local Branch of the Institute. An innovation was the visit of a speaker from abroad; Dr. Krautkramer of Cologne lectured on "Developments in the ultrasonic pulse technique."

During the session seven monthly Newsletters were circulated and members co-operated in extending the facilities of the Group's library scheme for providing reprints, etc.

Stress Analysis Group. *Chairman:* Mr. B. Sugarman. *Honorary Secretary:* Mr. V. M. Hickson. (183 members.)

The Group held its annual conference from March 26 to 28 in the University of Glasgow. Twenty-one papers were presented and discussed; the subjects included thermal stresses, photoelastic investigations, stress distribution in mines and dimensional theory. As part of the conference, visits were arranged to the Mechanical Engineering Research Laboratory, East Kilbride, and to the Royal College of Science and Technology, Glasgow. In May a whole-day meeting on "Contact Stresses" was held in the Institute's House. Papers were presented by eight specialists, and the discussion was lively and informative. A special visit was arranged in August, to the Mining Research Establishment at Isleworth. Members were given an account of the general work of the Establishment, and were able to see a series of demonstrations of stress analysis techniques applied to coal mining.

X-ray Analysis Group. *Chairman:* Professor E. G. Cox. *Honorary Secretary:* Dr. R. L. Gordon. (392 members.)

Two two-day conferences were held during the year. The spring conference, in the Department of Physics of Manchester College of Science and Technology, had no set topic, and papers were presented on a wide variety of subjects in the field of X-ray analysis. The autumn conference was held in London at The Institution of Civil Engineers, its general subject was "Metals," and two sessions on "Precipitation in Alloys" were held jointly with the Electron Microscopy Group; it was attended by over 200 persons. An exhibition of commercial crystallographic equipment was arranged in conjunction with this autumn conference. Two lecture meetings, in London in March and in Sheffield in October (jointly with the Sheffield crystallographic colloquium) were also held.

Collection of crystallographic data for the *A.S.T.M. X-ray Powder Data File* and for a new edition of the *Single-Crystal Index* has continued at University College, Cardiff, and at The University of Leeds respectively under the guidance of the Equipment Sub-Committee of the Group. During the year the Group Committee set up a new A.S.T.M. File Fund Sub-Committee to advise it on all financial aspects of the Fund including the provision of grants to assist data-collection programs. Panels of the Equipment Sub-Committee have continued the preparation of user-specifications for crystallographic equipment and apparatus. Specifications for high-temperature X-ray powder cameras and for sealed-off crystallographic X-ray tubes were issued during the year.

Four Newsletters were circulated to members during the year.

Extracts from Reports to the Board of representatives and nominees on joint and other Committees and organizations

The Board records its thanks to the several members who have represented the Institute on many bodies and thus helped in the "advancement and diffusion of a knowledge of physics." The large amount of work of a routine nature carried out by these committees is not reported below, where only matters likely to be of special interest to members are noted.

Parliamentary and Scientific Committee. The General Committee met ten times for lecture and discussion meetings on topics of the day, including: The present and future position of the universities, with special reference to scientific and technological education and research; space satellites and relevant matters; latest developments with regard to the use of thermonuclear energy at power stations; the work of the Department of Scientific and Industrial Research; and international science. Visits were paid to six scientific and technological establishments. The guest of honour at this year's lunch was H.R.H. The Duke of Edinburgh.

The Committee has been much concerned with the rating of scientific societies' premises and those of the Research Associations. Evidence is being given to a Committee set up by the Minister of Housing and Local Government which is specially to consider these matters. In April the Technical Education Sub-Committee sent representatives to the Minister of Education to discuss the future finances of Colleges of Advanced Technology. This Sub-Committee is also considering to what extent scientific matters could be dealt with more effectively on the radio and television programs, and in what ways it might be of assistance to some of the voluntary organizations that seek to keep the public informed on scientific and technological advances.

The Parliamentary members of the Committee have taken part in debates concerned with scientific and technological subjects and have asked a number of questions in the House of Commons on matters in which the Committee had interested itself. Partly on the initiative of the Board of the Institute the Chairman of the Committee made representations to the President of the Board of Trade with regard to the appointment as Comptroller-General of the Patent Office, of a person having no legal or scientific qualifications, despite the fact that all previous occupants of that office had been so qualified. An assurance that this would not form a precedent was given.

The Scientific members have expressed their deep gratitude to the Parliamentary members of the Committee for the efforts which they have made over the past several years which have now at last succeeded in making it possible to claim subscriptions to professional and learned societies for deduction from income-tax under Schedule E, as noted above in this Report.

Representatives of the Committee met a Russian scientific delegation and a Chinese cultural mission while they were in London in April.

British National Committee for Non-Destructive Testing. The Committee sponsored a Summer School at the Manchester College of Science and Technology, and is considering the holding of a symposium next year. It has had meetings with Japanese representatives in preparation for the Third International Conference, to be held in Tokyo in 1960, and has given some preliminary thought to the fourth Conference, to be held in London in 1963. It has also acted as a clearing house for many matters concerned with non-destructive testing, and is continuing its active encouragement of training.

The British Group for Computation and Automatic Control of the British Conference on Automation and Computation. This has been the first full year of existence of this new body, which is intended to co-ordinate the activities of rather more than twenty societies interested in various ways and to different extents in general problems of computation and automatic control. It remains to be seen how far it will be possible to create bridges between, say, engineers and physicists on the one hand, and on the other, accountants and bankers interested in some applications of modern computational aids. Useful, though modest, beginnings have been made, including the publication of a *Bulletin* which it is intended should be published about six times a year.

The Royal Society's Paul Instrument Fund Committee. The Committee held only one meeting during 1958 but, as in previous years, much business was transacted by correspondence. Five grants for new researches and one supplementary grant for extension of previous work were authorized, amounting in all to £18,665. The Committee has been encouraged by the slightly greater number of applications submitted, but still more would be welcomed.

Board of the British Nuclear Energy Conference. The Board met four times during the year and received reports on papers and meetings arranged by the constituent bodies and others, on nuclear energy and ancillary subjects. A selection of these was published in the *Journal of the British Nuclear Energy Conference.* The Conference was represented on the U.K. Papers Committee of the 1958 Geneva Conference on " The Peaceful Uses of Atomic Energy."

The Joint Panel on Nuclear Marine Propulsion is now represented on the Board ; this panel represents four institutions interested in the use of nuclear energy for ship propulsion.

The Board has invited the constituent bodies to encourage their local branches to hold joint meetings when subjects of interest to those working in the field of nuclear energy are to be discussed.

Committee of Management of Science Abstracts. Three meetings were held during the year. The question of the necessary expansion of the number of abstracts was continuously under review. Some departure from the full Universal Decimal Classification was considered desirable in the light of the rapid development of particular branches of physics.

Ministry of Labour and National Service's Panel on Special Regulations for Protection against Ionizing Radiations. The Committee held eight meetings during 1958. The main effort has been devoted to the drafting of factories regulations for unsealed sources of ionizing radiations. Comments and criticisms of the preliminary draft of the sealed sources regulations, have been considered, and they are now reaching the final stage prior to submission for Parliamentary approval.

Joint Committee for Chemical Analysis by X-ray Diffraction Methods. A further set of cards, the eighth, has been issued. The Joint Committee (with the American Society for Testing Materials and the American Crystallographic Association) met in Pittsburgh early in November, and the representative of The Institute of Physics was present. The ninth set of cards is in preparation, and should appear very early in 1959. Stocks of sets one to five are nearly exhausted, and are being reprinted in book form.

A further set of " Comments " on the *A.S.T.M. X-ray Powder Data File* has been issued as the result of work in the U.K. sponsored by the Institute.

The Physical Society's Exhibition Committee. The purpose of the Physical Society's Annual Exhibition is to display instruments and apparatus which are being developed for use in research in all branches of physics. The Committee continued its difficult work of deciding on the firms, research organizations, universities and hospital medical schools to be invited to exhibit, together with approving the items to be shown. The Committee was glad to note the maintenance of high standards in the Craftsmanship and Draughtmanship Competition.

National Council for Technological Awards, Board of Studies in Technologies other than Engineering. The first meeting of the newly-appointed Board of Studies was held in December, 1958. The main business of the meeting was the election of subject panels : the Applied Physics Panel consists of five Fellows of the Institute. One full-time and eight sandwich courses in physics or applied physics have now been approved for the Dip. Tech.

The Board concurred with the recommendation of the Board of Studies in Engineering that the Board of Scientific and Industrial Studies of the College of Technologists should include five members from industry, five from technical colleges and two from universities.

Applied Science Advisory Committee of the Birmingham College of Technology. The Committee commenced its activities in 1958, during which it met three times. It considers the work of the Departments of Chemistry, Mathematics, Metallurgy, Pharmacy and Biology and Physics, and has given some attention to matters such as postgraduate courses and research fellowships. It has appointed several sub-committees, including one on physics which has held two meetings with the Institute's representative as Chairman. The sub-committee has been concerned almost entirely with the numbers of students likely to be studying physics as a main subject, and has received considerable help from the Deputy Secretary of the Institute.

Governing Body of Brunel College of Technology. The Dip. Tech. course in Applied Physics is now well established in the College, and the first Diplomates will emerge this year. The course is an excellent one, recruits are of university entrance standard, and the aim of achieving honours standard at graduation is likely to be realized.

Governing Body of Croydon Technical College. The Science Department has now moved in its entirety into the new building which will eventually house the whole Technical College and the College of Arts.

An experimental venture last year was a full-time general science course of one term for secondary school teachers. The course was designed to enable them to teach science subjects up to G.C.E. Ordinary level, whether they had previous science training or not.

Science Advisory Committee of Croydon Technical College. Recruitment of teaching staff was reported to be difficult, but a recommendation by the Committee for facilitating recruitment was not accepted by the Governors. Opening of new buildings has made possible a limited amount of research by the teaching staff.

Science Advisory Committee of Ewell County Technical College. The Ordinary National Certificate Course in Applied Physics at the College is developing well and candidates were entered for the final examination for the first time this year. The College is now stopping the part-time course for the London external B.Sc.(General) degree. In place of this course it is planned to expand the Ordinary National Certificate work and in time to institute Higher National Certificate courses at the College. The London and Home Counties Branch of the Institute held a successful joint meeting with the College Faraday Society.

Court of the University of Exeter. The Report of Council to Court displayed good progress in the program for expansion, and in the funds provided to cover it. The annual intake for the Honours School of Physics is at present limited to thirty but will increase when the building progress is complete.

Science Advisory Committee of the Luton and South Bedfordshire College of Further Education. The Committee offered advice on the choice of subjects for short courses of a specialized nature which the College will give in the future. Some research work is now being undertaken by members of the staff of the Science Department.

The Court of Governors of the Manchester College of Science and Technology. The principal events of the year have been the opening of new College buildings, whose construction was commenced before the last war, and the opening of a Chemical Engineering department in a former cotton mill, the conversion of which occupied some fifteen months. The College has published plans for the development of neighbouring sites which it has acquired. There has been an increase in the grant from the University Grants Committee and some £60,000 was allocated to 1957-58 from the appeal funds.

Monmouthshire Technical Education Sub-Committee. The meetings of this Sub-Committee are attended by most of the Councillors (about 20). Suggestions to the Committee from the Principals for new buildings, new equipment and staff pay rises are sympathetically received and usually most requests are accepted by the Committee. In fact, the Committee would like to go at a faster pace than it is allowed by the Government grants.

Science Advisory Committee of the Salisbury and South Wiltshire College of Further Education. This Committee was formed in the early part of the year. The desirability of students taking an Ordinary National Certificate in Applied Physics instead of G.C.E. "A" level subjects was discussed and a special course of eight lectures on transistors arranged.

Advisory Sub-Committee for Applied Physics of the Welsh College of Advanced Technology. This Sub-Committee has been re-formed since the change in status of the College. It is now concerned only with Applied Physics. A four-year sandwich course for the College Associateship in Applied Physics has been recognized for the award of a Diploma in Technology which also obtains exemption from the academic requirements for Graduateship of The Institute of Physics.

Advisory Panel for Physics of the Yorkshire Council for Further Education. This panel has discussed the effect of the Ministry of Education's policy of withdrawing courses for which less than 10 students enrolled. It believes that in some areas in the County it may no longer be possible for part-time students to take advanced physics classes at all, either for a National Certificate or an external degree.

BRITISH STANDARDS INSTITUTION COMMITTEES

Committee on Units and Symbols Standards. The following British Standards in this Committee's field were published in 1958 :—B.S.2951 : *Glossary of terms used in high vacuum technology.* B.S.2990 : *Rationalized and unrationalized formulæ in electrical engineering.*

Standards which were ready for publication at the end of the year were : *Conversion factors and tables* (Part 1 of a much extended revision of B.S.350) and four new parts supplementing Part 1 (General) of B.S.1991, *Letters, Symbols, Signs and Abbreviations*, viz. : Part 2 : Chemical engineering, nuclear science and applied chemistry. Part 3 : Fluid mechanics. Part 4 : Structures, materials and soil mechanics. Part 5 : Heat engines. The Glossary of terms used in nuclear science has reached an advanced stage of preparation.

Technical Committee on Abbreviations and Letter Symbols. This Committee has continued its long and involved task of co-ordinating the symbols and abbreviations proposed by B.S.I. Committees, with each other and with those proposed by the International Standards Organization. It has been specially concerned with the new parts of B.S.1991 (see above)—*Letters, Symbols, Signs and Abbreviations.*

Instrument Industry Standards Committee. Proposals for new, revised or international standards have been considered by this Committee and its Sub-Committees, including the following :—graphical symbols for transductors, flow and temperature measuring instruments, optical instruments and components, light sources used in scientific equipment, direct reading hygrometers, output from instruments feeding into a data logger, and electronic analogue signals in process control.

Technical Committee on Glossary of Rubber Terms. Nine meetings were held and attention has been given to terms specific to rubber physics.

Technical Committee on Lead Glass for Radiation Protection. This Committee met twice and changed its terms of reference to " Glass for Protection against Ionizing Radiation." Drafts are being prepared in which the requirements for protective glasses for low and high energy ranges are separately treated. At present it is contemplated that specifications should contain absorption coefficients for ionizing radiations and for visible radiation and lead equivalents.

Sub-Committee on Glossary of Terms used in Nuclear Sciences. There have been twelve meetings concerned with further definitions of terms and symbols used in nuclear science. This stage of the work is now complete and a draft containing all definitions is being prepared for circulation and comment.

G. P. THOMSON,
President.

J. TAYLOR,
Honorary Treasurer.

H. R. LANG,
Secretary.

F. A. VICK,
Honorary Secretary.

THE INSTITUTE OF PHYSICS

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1958

1957 £		£
	To Office and general expenses :—	
4,566	Salaries and National Insurance	5,126
235	Staff superannuation	266
1,570	Rent, rates, heating, cleaning, maintenance, etc. ...	1,314
1,311	Board, Committees' and Officers' travelling expenses	1,360
599	Printing and stationery	709
1,806	*Bulletin* (net)	1,819
613	Postage and telephones	730
297	Miscellaneous expenses	384
10,997		11,708
1,215	,, Depreciation of furniture, fittings and office machinery	337
378	,, Amount written off expenditure on alterations, improvements and adaptation to House	378
985	,, Leasehold Redemption Policy	985
3,400	,, Grant to Endowment Trust Fund	4,050
46	,, Balance, being excess of income over expenditure carried to Reserve Fund	34
£17,021		£17,492

1957 £			£
15,013	By Members' subscriptions, entrance and other fees ...		15,898
74	,, Dividends and interest less tax		60
	,, Contribution from Endowment Trust Fund for alterations to premises, depreciation of furniture, fittings, office machinery and leasehold redemption policy :—		
1,289	Charged to cost of publications	850	
645	Charged to other work	425	
		—	1,275
—	,, Income tax recovered		259
£17,021			£17,492

THE INSTITUTE OF PHYSICS

BALANCE SHEET, 31 DECEMBER, 1958

1957			
£		£	£
	LIFE MEMBERSHIP FUND :—		
	As at 31st December, 1957	4,774	
	Less : Transfer to Reserve Fund in respect of deceased members	52	
4,774			4,722
	RESERVE FUND :—		
	As at 31st December, 1957	22,241	
	Add : Transfer from Life Membership Fund	52	
	Sinking Fund Leasehold Property ...	985	
	Interest on Phillips' Bequest	52	
	Income and Expenditure Account — Balance	34	
22,241			23,364
	CURRENT LIABILITIES :—		
	Payments received from members in advance ...	613	
	For expenses	2,183	
2,073			2,796
£29,088			£30,882

G. P. THOMSON, *President.*
J. TAYLOR, *Honorary Treasurer.*

1957		Cost to 31/12/57	Additions during year	Depreciation to 31/12/57	Depreciation during year	
£		£	£	£	£	£
	FIXED ASSETS :—					
910	FURNITURE, FITTINGS AND OFFICE EQUIPMENT ...	6,838	440	5,928	337	1,013
5,759	ALTERATION, IMPROVEMENT AND ADAPTATION OF PREMISES	10,289	—	4,530	378	5,381
6,669						6,394
	CURRENT ASSETS :—					
552	STOCK ON HAND—STATIONERY					611
620	DEBTORS—SUNDRY ACCOUNTS					610
7,287	DUE FROM ENDOWMENT TRUST FUND					7,997
34	SUBSCRIPTIONS IN ARREARS					93
	INVESTMENTS :—					
4,932	Quoted				4,932	
500	Unquoted				500	
	(*Estimated market value on 31 December, 1958, £4,957*)					5,432
7,880	LEASEHOLD REDEMPTION POLICY					8,865
614	BANK BALANCE AND CASH IN HAND					880
£29,088						£30,882

Report of the Auditors to the members of The Institute of Physics

We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purposes of our audit. In our opinion proper books of account have been kept by the Institute so far as appears from our examination of those books, and proper returns adequate for the purposes of our audit have been received from Branches of the Institute not visited by us. We have examined the above Balance Sheet and annexed Income and Expenditure Account which are in agreement with the books of the Institute. In our opinion and to the best of our information and according to the explanations given to us the said accounts give the information required by the Companies Act, 1948, in the manner so required and the Balance Sheet gives a true and fair view of the state of the Institute's affairs as at 31st December, 1958, and the Income and Expenditure Account gives a true and fair view of the excess of income over expenditure for the year ended on that date.

Spencer House, South Place, London, E.C.2.
10th February, 1959

KNOX, CROPPER, GEDGE & CO., *Chartered Accountants.*

THE INSTITUTE OF PHYSICS—ENDOWMENT TRUST FUND

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1958

1957 £		£
981	To Graduateship and National Certificate Examinations	1,183
2,702	„ Expenses of Branches and Groups	2,826
1,156	„ Conference expenses	121
690	„ Educational booklets and reports	642
40,395	„ Cost of production and distribution of publications sold	36,508
8,072	„ Proportion of overhead charges in connection with the work carried on by the Trust	8,390
645	„ Contribution to cost of repairs and alterations to House, depreciation of furniture and Leasehold Redemption Policy	425
£54,641		£50,095

1957 £		£
1,132	By Fees for examinations	1,338
157	„ Donations	—
566	„ Interest	1,266
46,145	„ Receipts from publications including advertisements ...	41,360
3,400	„ Grant from The Institute of Physics	4,050
231	„ Non-members' conference fees	319
3,010	„ Balance, being deficit carried to Trust Fund	1,762
£54,641		£50,095

BALANCE SHEET, 31 DECEMBER, 1958

1957 £		£	£
	Endowment Trust Fund :—		
	As at 31st December, 1957	801	
	Add : Deficit from Income and Expenditure Account	1,762	
		£2,563	
	Current Liabilities :—		
19,743	X-ray Index Fund	22,795	
10,101	Publication subscriptions in advance	12,707	
4,198	Printing and publishing expenses and amounts in advance	3,496	
7,287	Due to The Institute of Physics	7,997	
			46,995
£41,329			£46,995

1957 £		£	£
	Investments :—		
15,657	Quoted	15,657	
10,000	Unquoted	10,000	
	(*Estimated market value on 31 December, 1958, £25,178*)		25,657
201	Savings Bank deposits		—
1,942	Stock on hand—Publications and dispatch materials ...		2,059
6,095	Sundry debtors, publications, etc.		5,357
6,633	Bank balances and cash in hand		11,359
801	Endowment Trust Fund—Balance per contra		2,563
£41,329			£46,995

G. P. THOMSON, *President.*
J. TAYLOR, *Honorary Treasurer.*

We have audited the above Balance Sheet and have obtained all the information and explanations we have required. We have verified the Bank Balances and the Investments. In our opinion such Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Fund according to the best of our information and the explanations given to us and as shown by the books of the Fund.

Spencer House, South Place, London, E.C.2.
10th February, 1959

KNOX, CROPPER, GEDGE & CO., *Chartered Accountants.*

THE INSTITUTE OF PHYSICS—BENEVOLENT FUND

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1958

1957 £		£	1957 £		£
506	To Grants	857	744	By Members' subscriptions and donations	781
			—	,, Donation from Australian Branch Special Fund ...	200
	,, Balance, being excess of income over expenditure		558	,, Income from Phillips Trust	570
			—	,, Other donations	16
1,051	carried to Capital Account	1,375	172	,, Interest on investments	316
			83	,, Royalties on books	349
£1,557		£2,232	£1,557		£2,232

BALANCE SHEET, 31 DECEMBER, 1958

1957 £		£	£	1957 £		£
	CAPITAL ACCOUNT :—			2,542	GOVERNMENT SECURITIES, at cost	7,042
	On 31st December, 1957	7,075			*(Estimated market value at 31 December, 1958, £6,637)*	
	Add : Transfer from Income and Expenditure			18	DEBTORS	259
	Account	1,375		493	CASH AT BANK—Current Account	622
7,075			8,450	4,022	Deposit Account	527
£7,075			£8,450	£7,075		£8,450

J. TAYLOR, *Chairman of Fund Committee.*
H. R. LANG, *Secretary of the Committee.*

We have audited the above Balance Sheet and have obtained all the information and explanations we have required. We have verified the Bank Balances and the Investments. In our opinion such Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Fund according to the best of our information and the explanations given to us and as shown by the books of the Fund.

Spencer House, South Place, London, E.C.2.
10th February, 1959

KNOX, CROPPER, GEDGE & CO., *Chartered Accountants.*

The Institute's Journals

PRINCIPAL CONTENTS OF THE APRIL, 1959, ISSUES

The price of the annual volume (twelve parts) of each journal is £6 to non-members and £1 10s. to members of the Institute.

Journal of Scientific Instruments : Volume 36, No. 4

Use of radial gratings in a small inclinometer. By A. Lewis and I. R. Young, Grad.Inst.P.

Some of the factors involved in the choice of gratings for use in the digital measurement of angles are discussed. This problem is accentuated in the case of the instrument described by its small size and the decision, therefore, to use two complete circles for the gratings, instead of the less critical method using one circle and adjustable grating cursors. The tolerances which have to be achieved for satisfactory performance are considered and the instrument itself, a pendulous inclinometer intended to measure the pitch angle of wind tunnel models, is described.

Resistance strain gauges of low temperature sensitivity. By G. R. Higson.

Strain gauges manufactured from a series combination of Nichrome and Advance wires may be used in quarter-bridge circuits to measure static strains where the temperature is slowly varying. The average temperature drift corresponds to 20 lb/in.^{2} × °C on steel and 2·5 lb/in.^{2} × °C on dural and the sensitivity drop is less than 5% up to 250°C. When used in a full-bridge circuit the drift should be negligible.

Automatic scanner for electrophoresis and chromatography paper strips. By G. Smiljanic and T. Rabuzin.

A device for scanning electrophoresis and chromatography paper strips is described. A pen recorder traces the curves of the optical density, integral of the optical density, radioactivity intensity and integral of the radioactivity intensity as a function of position of the paper strip. The scanning is carried out automatically.

Recording projection micrometer. By N. A. Hunt, P. C. Russell, E. A. Stewardson and J. E. Wilson.

This instrument, which may easily be adapted for alternative uses, was designed for making abscissa measurements on microdensitometer curves of X-ray multiplets. It is essentially a printing micrometer in which the curve is positioned by the use of an enlarging optical projection arrangement.

Tensile testing machine for microscopic specimens. By D. M. Marsh.

The problems of the mechanical testing of whiskers and thin films having gauge lengths down to 0·2 mm and cross sections as low as 8×10^{-7}mm^2 are discussed. A machine is described which gives load-strain curves for such specimens with minimum load increments of 0·5 mg *f* and with extension readings repeatable to 0·019 μ. A torsion balance applies and measures the load and the strain is obtained by a null method using a marker and a special optical arrangement in a projection microscope. A number of special design features are incorporated to ensure high stability.

Linear voltage temperature furnace for thermal analysis. By A. J. Martin and K. L. Edwards.

A furnace is described which may be operated in a vacuum or an inert atmosphere, and which was developed for therma analysis studies of beryllium and its alloys. Extremely rapid heating and cooling rates may be employed if required, or, with slow heating and cooling rates, a linear variation in voltage with time will produce a correspondingly near-linear variation in temperature. This is of great value in thermal analysis work, and is very much cheaper than the electronic controllers or mechanical cam devices that are usually necessary.

Liénard phase plane integraph. By R. Butler, A.Inst.P.

A mechanical linkage is suggested for obtaining trajectories, corresponding to damped oscillations, in the Liénard plane. Its construction is based on the Henrici-Coradi instruments, although, as a second order differential equation is being analysed here, the mechanism is more intricate.

Analogue computer for the solution of product integrals. By F. D. Penny and J. W. McHugo, A.Inst.P.

The computer will accept up to three input variables simultaneously; they are presented in the form of recorder chart traces which are traversed mechanically, but are followed by hand. The instantaneous product of the input variables, or of some pre-selected function of them, is formed and charted. Mechanical integrators compute the integrals of each of the input variables and of the product. The particular arrangement described computes $\int ab\sqrt{c}dt$, $\int adt$, $\int bdt$ and $\int \sqrt{c}dt$ where $a(t)$, $b(t)$ and $c(t)$ are the input variables.

Apparatus for the measurement of specific heat of metals. By W. H. Martin and J. Rixon.

An apparatus is described which enables the measurement of the specific heat of metals to be made *in vacuo* up to a temperature of at least 500°C.

The specimen in the form of a flat cylinder has its temperature steadily increased by a metered amount of electrical energy supplied by an internal heater. Radiative heat losses are eliminated by means of an adiabatic screen which surrounds the specimen and which is maintained at the same temperature. The rate of temperature rise can be controlled by the energy input enabling specific heat to be investigated over small temperature ranges. An accuracy of within ±3% has been obtained at temperatures up to 500°C.

The design of mercury thermometers for calorimetry. By J. A. Hall, F.Inst.P., and Vera M. Leaver.

The emergent column error and the uncertainties caused by irregular movement of the meniscus in an open-scale thermometer are discussed. It is considered preferable to calibrate calorimetric thermometers at total immersion unless the ambient temperature in use is considerably below that of the calorimeter. It is shown that irregularity of movement of the meniscus is, to a sufficiently close approximation, proportional to the external pressure coefficient of the thermometer β_e divided by the diameter of the bore d. If these are expressed in deg. C × 0·001/cm of mercury and mm respectively, β_e/d should not exceed 15 when a reproducibility of reading of ±0·002°C is desired. Further, it is undesirable to use a capillary having a diameter of less than 60 μm. The paper includes a chart by means of which the appropriate sizes of bulb and capillary tubing for a thermometer of given dimensions and scale length may be selected.

Method of double-beam spectrophotometry in the vacuum ultra-violet. By J. F. James.

An apparatus is described which permits the measurement of absorption coefficients in the far vacuum ultra-violet, using an unsteady radiation source. The beam emerging from a monochromator is divided, and one part is passed through an absorber cell. Two photomultipliers and a bridge network are used to measure the intensity ratio with and without an absorber in the cell. Absorption coefficients can be measured with an accuracy of 1% or better at wavelengths down to 800Å.

Method of reducing the effects of vibration in a magnetic ring balance. By C. A. Clark, A.Inst.P., and J. E. Whittle.

A damping arm, pivoted near its centre of gravity, has been added to the ring of a Sucksmith magnetic balance in order to reduce the response to external vibration. The mass of the damping arm is distributed to provide a large inertia to vibration at the resonance frequency of the spring system, without appreciably affecting its sensitivity.

Contour mapping microdensitometer. By P. Hariharan, A.Inst.P., and M. S. Bhalla.

The instrument described in the present paper is basically a scanning microdensitometer in which a gating circuit is utilized in conjunction with an optical printing system to plot automatically a contoured density map of the photograph which is being scanned. The gating circuit used is comparatively simple and extremely stable and permits the insertion of as many contours as are required, at specified values of density.

British Journal of Applied Physics : Volume 10, No. 4

CONFERENCE REPORT

Summarized proceedings of a Conference on solid state memory and switching devices—London, September, 1958.

Some of the newer devices which may form the basis of present or future computers were discussed at a Conference of the Electronics Group of The Institute of Physics held in London on September 26 and 27, 1958. The papers and discussion are summarized in the present report.

ORIGINAL CONTRIBUTIONS

Investigation of the ignition of a gas by an electric spark. By D. R. Lintin and E. R. Wooding, A.Inst.P.

By using flashes of microsecond duration it has been possible to obtain a series of shadowgrams showing the development of steadily propagating flames.

About 100μs must elapse before any difference can be detected between the flame kernels which will propagate and those which subseqently degenerate. The critical radius, at which this difference becomes apparent, has been measured in various mixtures of methane and air. The time to reach this critical stage has been determined. The flame speed has been calculated and after assuming a value for the final flame temperature, the burning volocity has been estimated.

From the results obtained it has been possible to outline the mode of growth of the flame and to state which conditions favour ignition.

Unifying design principle for the resistance network analogue. By F. C. Gair.

The object of the present paper is to simplify the design of resistance network analogues. This is achieved, without any loss of accuracy, by the use of what can be called the " cell principle," which is an extension and generalization of the method of MacNeal. Poisson's equation is integrated over the volume of a representative small cell. In this form it is much easier to appreciate the analogy with the resistance network, and hence to arrive immediately at the relevant design parameters. The method applies not only to the usual type of network with equal meshes, but also to networks with unequal meshes, or subdivided meshes, and further to the representation of the Dirichlet, Neumann or Fourier boundary conditions on rectangular or arbitrarily curved boundaries.

More complicated equations than Poisson's can also be represented by a resistance network. By considering these equations as generalizations of Poisson's equation in an appropriate Riemann space, the corresponding design parameters are achieved. This formulation can equally well be used as the basis for any numerical solution of the equations.

Effect of deformation of the surface texture on rolling resistance. By J. Halling.

The paper describes the results of a series of experiments showing the variation of the coefficient of rolling resistance λ, with increasing load for hard steel rollers on a variety of steel surfaces. It was found that the initial value of λ, and the rate of change of λ with increasing load, were both reduced by a series of loading cycles in which the maximum load in any given cycle exceeded the maximum load of the preceding cycle. These changes were also found to be greater for the rougher surfaces.

The effect of yield stress was also studied and increasing yield stress produced slightly larger values of λ. In all the tests a change of behaviour occurred at a load which was markedly dependent on the bulk yield stress of the material and marginally dependent on the surface roughness.

The experimental results are interpreted in terms of the resistance to rolling being dependent on two factors; (*a*) the hysteresis loss concept, and (*b*) the requirement for the smooth roller to surmount the irregularities on the surface,

Use of an electronic analogue computer with resistance network analogues. By J. Ph. Korthals Altes.

This paper describes a method of solving partial differential equations of the elliptical type, with the aid of an electronic analogue computer in conjunction with a resistance network. Although this method is iterative the adjustments are made automatically by means of electronic memory elements and a switching mechanism. Some results are given.

In case the iteration process proves to be divergent an additional voltage source connected with a well-chosen node may offer a solution.

Analysis of a polydisperse aqueous spray from a high-speed spinning disk atomizer. By D. J. Ryley.

The analysis covers experiments made using flat rotating disks of 2, 3 and 5 cm diameter having controlled matt working surfaces. Rotational speeds varied from 19,000–70,000 rev/min and water feed rates were 0·121, 0·421 and 0·771 g/s. The independent variation of Sauter mean diameter (S.m.d.) and of maximum droplet diameter with disk size, liquid flow rate and rotational speed were found and the general correlation is expressed using dimensionless groups. The extent of the dispersion is numerically expressed as a Rosin-Rammler distribution constant.

Good correlation was found between both (*a*) S.m.d. and (*b*) maximum droplet diameter, and the appropriate products of dimensionless groups. The distribution constant is expressed empirically in terms of speed and flow rate, but the correlation is less satisfactory than in the case of (*a*) and (*b*). No information is given on the mode of fracture, but limitations of the analytical method are explored.

Excitation and ionization rates of mercury in discharge plasmas. By M. A. Cayless, A.Inst.P.

Excitation and ionization rates of mercury by inelastic electron collisions in gas discharge plasmas with Maxwellian electron energy distributions have been calculated from the collision cross-section data for electron temperatures between 5,000 and 54,000°K. Published cross-section data have been used where available, and estimates have been made in several cases of interest for which no data are known.

Analysis of the lighter elements by total reflextion of their characteristic X-ray wavelengths. By A. Franks, A.Inst.P., and R. F. Braybrook.

The analysis of characteristic X-ray wavelengths in the region of 10Å has been achieved by a technique employing total external reflection.

THE COLLEGE OF AERONAUTICS

Applications are invited from candidates with suitable academic qualifications and experience for the following appointments in the Department of Aircraft Materials:

LECTURER in nuclear metallurgy or materials, to teach at postgraduate level. Opportunities exist for research, and publication is encouraged. Candidates should have some experience of nuclear engineering and be qualified to lecture in the fundamental aspects of the subject. Salary in scale £900 × £50 – £1,350 × £75 – £1,650 p.a., with F.S.S.U. and family allowance.

DEMONSTRATOR in physical testing. To assist in the organization and supervision of laboratory teaching within the department. Opportunities exist for both lecturing and research. Industrial experience in the field of non-destructive testing an advantage. Salary in scale £600 × £25 – £1,000 p.a., with F.S.S.U. and family allowance. Subsequent promotion to Lecturer is possible if suitably qualified.

RESEARCH FELLOW in physical metallurgy or metal physics, to work in the field of deformation and dynamic stressing. Considerable research facilities exist and the successful candidate will be free to choose any line of study related to the interests of the college. Previous research experience is essential. Salary in range £650 – £900 p.a. (Research Fellowship) or £1,000 to £1,200 p.a. (Senior Research Fellowship) with superannuation under F.S.S.U. and family allowance.

In all cases the commencing salary within the prescribed scale will depend upon age, qualifications and experience. Consideration will be given to candidates' housing requirements. Applications giving full particulars and the names of three referees should be forwarded to the Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks. Further particulars available.

UNIVERSITY COLLEGE OF NORTH WALES, BANGOR

Applications are invited for the post of ASSISTANT LECTURER in physics. The salary scale is £700 × £50 – £850 p.a., and in addition there are F.S.S.U. benefits and family allowances. The appointment will date from October 1, 1959.

Two copies of the application should reach the undersigned, from whom further particulars may be obtained, not later than April 30, 1959. Kenneth Lawrence, Secretary and Registrar.

PHYSICAL CHEMIST OR METAL PHYSICIST required for unclassified fundamental studies of the properties of surface films on metals in relation to problems of nuclear energy development. Ph.D. or equivalent experience desirable. Work suitable for higher degree in appropriate cases. Salary to £750 p.a. Applications to Professor J. G. Ball, Department of Metallurgy, Imperial College, London, S.W.7.

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(FACULTY OF TECHNOLOGY IN THE UNIVERSITY OF MANCHESTER)

APPOINTMENT OF

LECTURER OR ASSISTANT LECTURER IN PHYSICS

Applications are invited for a Lectureship or an Assistant Lectureship in physics in the college with corresponding title and status in the University of Manchester. The successful candidate will be required to take part in the teaching of the department which is almost entirely concerned with internal degrees of the Faculty in physics and other subjects. He will also be allowed ample time for research under the general direction of Professor H. Lipson, the main subjects at present being physical optics and X-ray diffraction. Salary: Lecturer—£900 × £50 – £1,350 × £75 – £1,650. Assistant Lecturer—£700 × £50 – £800.

Commencing salary in each case according to qualifications and experience. Superannuation under the F.S.S.U. Family allowances.

Conditions of appointment and forms of application may be obtained from the Registrar, The Manchester College of Science and Technology, Manchester, 1, to whom applications must be returned by Saturday, April 25, 1959.

UNIVERSITY OF GLASGOW UNIVERSITY STUDENTSHIPS AND FELLOWSHIPS

Applications are invited for University Studentships and Fellowships for experimental or theoretical research in nuclear and elementary particle physics.

Salary scale: Studentships: £350 – £600 per annum, according to qualifications, with a tenure of three years. Fellowships: £700 – £900 per annum, according to qualifications. Tenure three years on appointment, with possible renewal for further period of two years. These Fellowships will be superannuated under the F.S.S.U.

Applications stating age, academic qualifications, research experience and names of two referees, should be sent to the Professor of Natural Philosophy, The University, Glasgow, W.2, before May 9, 1959.

UNIVERSITY COLLEGE OF NORTH WALES, BANGOR

Applications are invited for the post of ASSISTANT LECTURER in electronic engineering. Candidates should have good qualifications in light current electrical engineering or in physics.

The salary scale is £700 × £50 – £850 p.a., and in addition there are F.S.S.U. benefits and family allowances. The appointment will date from September 1, 1959.

Two copies of the application should reach the undersigned, from whom further particulars may be obtained, not later than April 30, 1959. Kenneth Lawrence, Secretary and Registrar.

GRADUATE

Required for Arc Discharge laboratory at Woolwich on design and development of new and improved forms of continuously burning xenon arc lamps and electronic flash discharge tubes.

Interesting work offering full scope for originality in applying the basic fundamentals of the several branches of Physics to the design and testing of practical devices.

Knowledge of arc discharge and high vacuum techniques preferable but not essential.

TECHNICAL ASSISTANT

also required to assist in this work. HNC or equivalent in Physics, Electrical Engineering, etc., desirable.

Write for application form to:

Staff Officer, Ref. 744/47,
SIEMENS EDISON SWAN
LIMITED
WOOLWICH, LONDON,
S.E.18

Insurances for Physicists

☐ **RETIREMENT PENSIONS** with full Tax Relief (1956 Finance Act)

☐ **ENDOWMENT ASSURANCE.** An adaptable policy providing protection for dependants, a good investment and a Tax-free capital sum on retirement.

☐ **NON-CANCELLABLE SICKNESS AND ACCIDENT INSURANCE,** providing an income during disablement up to age 65.

☐ **HOUSEHOLDERS COMPREHENSIVE INSURANCE** on Buildings and/or Contents with No Claims Bonus.

☐ **MOTOR INSURANCE.** Special Scheme with immediate 33⅓% No Claims Bonus (PLEASE SEND DETAILS OF CAR FOR QUOTATION PURPOSES)

Name.. Date of Birth..............................
(BLOCK LETTERS PLEASE)

Address ....

These policies are of particular interest to physicists.

For further details please complete this form and send to :

WALTER HERRIOT & CO. LTD.
Incorporated Insurance Brokers
Broad Street House, 54 Old Broad Street, London, E.C.2
(Telephone : LONdon Wall 7007/8)

G. V. PLANER LTD.

Consultants and Research Laboratories, Windmill Road
Sunbury-on-Thames, Middlesex
(Sunbury 2266)

Applications are invited for the following appointments :

(*a*) Senior Physicist for advanced research and development in *semiconductors*.

(*b*) Senior Physicist or Physical Chemist for research in *electrical ceramics* and other *dielectrics*.

The starting salaries for both appointments are between £1,200 and £2,000 according to background. A good degree, experience and ability to take responsibility are essential. The posts offer considerable scope for advancement in this progressive and rapidly expanding company. Pension scheme. The laboratories are situated in good residential area within easy reach of London.

SOLID-STATE RESEARCH AND DEVELOPMENT

An expanding research establishment situated in a country district in South Northants requires GRADUATES IN PHYSICS, CHEMISTRY AND METALLURGY to join groups working on the properties of semi-conducting materials, and also on the development of new devices.

A bias of interest towards basic studies in the solid state is required, and experience with semi-conductors would be an advantage. Some of these posts are of a more senior nature, and selected candidates will be invited to lead small groups working on fresh projects. Starting salaries related to qualifications and experience. When replying please quote as reference Solid State RD/4. Personnel Dept., The Plessey Co. Ltd., Caswell, Nr. Towcester, Northants.

A PHYSICIST OR ENGINEER is required for development work on a wide range of acoustic problems including ultrasonic pulse transducers, electro-acoustic filters and ultrasonic flaw detection. The applicant must have a good academic record and a thorough background of experience in this or allied fields. He must be capable of initiating work and carrying it through without close supervision. A progressive salary will be paid and pension scheme is in operation. Please send details immediately to Glass Developments Ltd., Sudbourne Road, S.W.2.

WELSH COLLEGE OF ADVANCED TECHNOLOGY

CATHAYS PARK, CARDIFF

DEPARTMENT OF APPLIED PHYSICS

Applications are invited for the post of HEAD OF DEPARTMENT. Applicants must have had good teaching, industrial and/or research experience. The salary will be in accordance with Grade IV of the Burnham Report, i.e. at present £1,837 10s.–£1,995 × £52 10s. increments.

Further particulars and application forms may be obtained from the Principal at the college, to whom they should be returned as soon as possible. Robert E. Presswood, Director of Education and Clerk to the Governors, City Hall, Cardiff.

SUNDERLAND EDUCATION AUTHORITY

TECHNICAL COLLEGE

Applications are invited for the post of LECTURER in physics: duties to commence on September 1, 1959. Applicants should have honours degree: research or industrial experience an advantage.

Salary: £1,200 × £30–£1,350 plus 5% increase.

Further particulars and form of application from the Registrar, The Technical College, Sunderland. W. Thompson, Director of Education, 15 John Street, Sunderland.

UNIVERSITY OF HONG KONG

CHAIR OF PHYSICS

Applications are invited for the above Chair, vacated on the Professor's appointment to another post.

Annual salary (superannuable) is £3,250 for a man or £2,450 for a woman, together with a superannuable expatriation allowance of £350 a year if applicable. The equivalent of income tax in the Colony is comparatively low.

First-class passages are provided for expatriate staff and their families on first appointment and leaves. A furnished flat or house is provided at a reasonable rental.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1. Applications close, in Hong Kong and London, on May 30, 1959.

PHYSICIST (PRINCIPAL SCIENTIFIC OFFICER) required by L.C.C. in the scientific branch at County Hall for research work on properties of materials and in the field of health physics. Good honours degree in physics required. General physical experience and knowledge of radio-chemical equipment desirable. Salary within scale £1,245–£1,482 10s. according to qualifications and experience. Permanent and pensionable. Apply for form by April 24, to Medical Officer of Health (PH/D. 1/A), County Hall, London, S.E.1. (600)

UNIVERSITY OF SYDNEY AUSTRALIA

SENIOR LECTURESHIP OR READERSHIP IN PHYSICS

Applications are invited from senior theoretical astrophysicists for the position of Senior Lecturer or Reader in physics at the Theoretical Group of the School of Physics.

The Theoretical Group has a strong team at present in the fields of field theory, low temperature theory, nuclear physics and shower theory. Silliac, the automatic digital computer, is housed in the School of Physics and first priority in its use is given to physicists in the School. The School also has a large experimental group active in the field of cosmic rays. Steps are now being taken to establish an astronomy group in the school with its own telescope.

The salary for a Senior Lecturer is within the range £A2,200 × £80–£2,600 per annum plus cost of living adjustment. The salary for a Reader is £A2,850 per annum plus cost of living adjustment. Salaries are subject to deductions under the State Superannuation Act. The commencing salary will be fixed according to the qualifications and experience of the successful applicant. Under the Staff Members' Housing scheme in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house. Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1.

Applications close, in Australia and London, on May 29, 1959.

THE BRITISH FOOD MANUFACTURING INDUSTRIES RESEARCH ASSOCIATION

LEATHERHEAD, SURREY

A PHYSICIST OR PHYSICAL CHEMIST is required to join a small team concerned with research into problems arising in the manufacture of chocolate. The field of work on which the applicant would be initially engaged will involve theoretical and practical investigations into the rheological behaviour of this material.

The candidate should have a university degree or equivalent qualification. Some experience of rheology would be an advantage but is not essential.

The salary appropriate to the appointment will be in the range £920 to £1,130 depending on age, qualifications and experience. There is a possibility of subsequent promotion to higher grades. Apply in writing to the Director of Research, British Food Manufacturing Industries Research Association, Randalls Road, Leatherhead, Surrey. Applications should be marked "Private and Confidential."

THE BRITISH BOOT SHOE AND ALLIED TRADES RESEARCH ASSOCIATION

Vacancy for **SECTION LEADER** in Physics Dept. Interesting and varied laboratory work, including investigation of performance characteristics of shoes and materials (wear, waterproofness, comfort properties, etc.). Prospects of rapid advancement for young person possessing enthusiasm and practical ability. Starting salary £750–£1,100. Superannuation. Qualifications: Degree in physics (or general science including physics) and laboratory experience, preferably in instrumentation or materials testing. Applicants without degrees will be considered on evidence of other qualifications, experience and proved ability. Applications to: Director, Satra House, Kettering, Northants.

UNIVERSITY OF READING

Applications are invited for a senior appointment as **RESEARCH PHYSICIST** in the Department of Physics. The work will involve electrical measurements applied to the study of surface contamination processes on semiconductors. Experience in the use of ultra-high vacuum systems or in the chemical physics of surfaces is desirable. Salary according to qualifications and experience. Further particulars may be obtained from the Professor of Physics, University of Reading, Physics Research Laboratories, Upper Redlands Road, Reading, to whom applications should be submitted as soon as possible.

BRADFORD INSTITUTE OF TECHNOLOGY

Principal :

E. G. Edwards, Ph.D., B.Sc., F.R.I.C.

Expansion of the work of the Institute, especially in the courses for the Diploma in Technology, has created vacancies in the various departments and applications are invited for the posts of :—

READERS, SENIOR LECTURERS AND LECTURERS IN PHYSICS

Successful candidates will be given adequate facilities to undertake and direct research and suitable technical assistance and equipment [illegible] available. Senior members of staff are encouraged to undertake consultant work in industry and may retain fees paid for such work. The grading of the appointment [illegible] depend upon qualifications and experience and the salary scales for men will be in accordance with the Burnham Technical Award as follows :—

Reader—£1,627 10s. to £1,890 per annum. Senior Lecturer—£1,417 10s. to £1,627 10s. per annum. Lecturer—£1,260 to £1,417 10s. per annum. In the case of very highly qualified applicants for the post of Reader, the Governors may, subject to agreement by the Minister of Education, pay such higher salary above the maximum of the scale as would be appropriate.

Previous industrial or research experience at a suitable level will be taken into account in fixing the commencing salary. Further particulars and forms of application may be obtained from the Registrar, Bradford Institute of Technology, Bradford 7.

W. H. Leathem, Clerk to the Governors.

A PHYSICIST for work on ultrasonic pulse transducers, flaw detectors and electro-acoustic filters. Candidate must be able to work without supervision and have suitable experience. B.Sc. or H.N.C. standard. Details immediately to Glass Developments Ltd., Sudbourne Road, Brixton, S.W.2.

UNIVERSITY OF GLASGOW

UNIVERSITY STUDENTSHIPS AND FELLOWSHIPS

Applications are invited for University Studentships and Fellowships for experimental or theoretical research in solid state physics. Salary scale : Studentships : £350 – £600 per annum, according to qualifications, with a tenure of three years. Fellowships : £700 – £900 per annum, according to qualifications. Tenure three years on appointment, with possible renewal for further period of two years. These Fellowships will be superannuated under the F.S.S.U.

Applications stating age, academic qualifications, research experience and names of two referees, should be sent to the Professor of Natural Philosophy, The University, Glasgow, W.2, before May 30, 1959.

PRINTED BY F. J. MILNER AND SONS LIMITED, COMMERCE ROAD, BRENTFORD, MIDDX.

BRISTOL EDUCATION COMMITTEE

The College of Technology

(Selected for development into a College of Advanced Technology)

The Governors invite applications for following posts to commence in September, 1959:—

Two Lecturers in mathematics with honours degree in mathematics or statistics and teaching and research or industrial experience involving application of mathematics to engineering or scientific problems. Experience in statistical work required in one of the posts.

One Assistant grade B in mathematics with degree in mathematics or engineering and teaching experience and research or industrial experience involving application of mathematics to engineering or scientific problems.

Two Lecturers in physics with honours degree in physics and teaching and research or industrial experience in some aspect of applied physics. For one of the posts, experience in electronics required.

One Assistant grade B in physics with degree in physics and teaching and research or industrial experience in some aspect of applied physics.

Salary: Burnham Scales:—
Lecturer:—Men—£1,260 × £31 10s.–£1,417 10s.
Women—£1,008 × £25 4s.–£1,134 plus equal pay increments.
Assistant grade B:—
Men—£682 10s. × £26 5s.–£1,076 5s.
Women—£609 × £21–£861 plus equal pay increments.

Placing on scale dependent on approved industrial and teaching experience and, in case of grade B Assistants, there will also be additions for degree and training. Application form, returnable not later than April 16, 1959, and details from Registrar, College of Technology, Ashley Down, Bristol 7.

ROYAL TECHNICAL COLLEGE, SALFORD

Applications are invited for the following posts :—

READER IN PHYSICS. The post is primarily for the direction and organization of research. The person appointed will be required to initiate and supervise research work in his chosen field. Good research experience essential.

SENIOR LECTURER IN PHYSICS. Good honours degree, together with good research and/or industrial experience, or good teaching experience and some research or industrial experience. Duties will include lecturing to special degree standard.

ASSISTANT, GRADE "B," IN PHYSICS. Candidates for this post must be able to teach up to degree level and should have a good honours degree. Research work will be encouraged.

Salaries are in accordance with the Burnham Technical Scale at present :—
Readers : Men—£1,627 10s. by £52 10s. to £1,890. Senior Lecturers: Men—£1,417 10s. by £52 10s. to £1,627 10s. Women—£1,336 9s. to £1,627 10s. Assistants, Grade "B": Men—£682 10s. by £26 5s. to £1,076 5s. Women—£661 10s. to £1,076 5s. Successful applicants may be placed at intermediate points in these scales, in accordance with previous experience in an equivalent capacity and/or industrial experience.

Further particulars and forms of application may be obtained from the Registrar, Royal Technical College, Salford 5, Lancs., to whom completed applications should be returned as soon as possible.
R. Ribblesdale Thornton, Clerk to the Governors.

COURSE

ROTHERHAM COLLEGE OF TECHNOLOGY

Physics Department

A short full-time course on High Vacuum Technology will be held from June 29 to July 3, 1959.

The course is designed to cover the fundamentals of the production of high vacua. It should be of particular value to inexperienced intending users of vacuum equipment and research workers who expect to use vacuum techniques in their investigations.

Applications and enquiries should be made to The Registrar, College of Technology, Howard Street, Rotherham, Yorkshire.